OMNI

SEPTEMBER 1979 $2.00

FANTASTIC BEINGS:

HIGH-SCHOOL CONFIDENTIAL:

THE ORBITING GOURMET:

PLUS:

B.F. SKINNER:

OMNI

SEPTEMBER 1979

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Cover art for this month's Omni is a watercolor by the American artist Alan Magee. The painting was originally done for the cover of Henry Miller's Time of the Assassins *(Simon & Schuster). Magee is a self-taught artist who lives and paints in Maine.*

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STAN KENT

"There is an age crisis now facing the aero-space business The likelihood that a young engineer will join NASA's space program payroll is virtually nonexistent."

Whether the United States is first, second, or no-show in space depends upon many factors, but pervading all concerns, be they budgetery or otherwise, is a basic lack of creativity To ensure leadership in space, perticulerly dunng austere years, requires fresh, innovative thinking New concepts and approaches need to be explored, but NASA, more comfortable with a do-nothing, low-profile approach, is shirking grand concepts Perhaps fearful of an Apollo-type backlash NASA has done its best to decline funding for certain advanced projects prompting harsh political criticism and review from the pro-space ranks of the Congress To quote Representative Don Fuqua of Florida 'There is insufficient commitment . The space program is dying on the vine "

One real consequence of this backtash is the age crisis now facing the aerospace industry The aerospace slump that followed funding reductions for Project Apollo apart from hurting the bank balances and attitudes of many engineers, caused the industry to stop hiring young people because of an overall lack of jobs This trend has started to reverse, with boomlike hiring going on in Seattle and Los Angeles, but most of these bnght new employees end up in the aero rather than the space, side of the business The available jobs are in commercial or defense aircraft programs almost no newly graduated students go to work in the space business NASA itself is in a substantially worse position Feced with federally mandated work-force reductions, e young engineer is unlikely to be put on NASA's space program payroll

The anti-space-expenditure lobby (otherwise known as the Office of Management and Budget) argues that there is no need for concern Proponents say that there is no need for a dynamic space program Yet the pulse of the nation is throbbing with rockets' fire Groups supportive of the space program are forming all over the country, and it NASA, the Office of Management and Budget, and the President will open their eyes and ears, they will realize that the Apollo backlash has been beaten The public wants a strong, dynamic, and expanded space program, and government and industry should prepare to deliver

If the aerospace industry is to meet public demands, it will need to replenish its work force as retirement and attrition take their inevitable toll. Many of the space program's planners and chief protagonists will, like old soldiers fade away The program will lose direction and be unable to maintain what President Carter called the "leadership of the United States in space," unless some attempt is made to involve young people if only so that they can benefit from the experience of the first generation of space pioneers

Involvement of young people in the space program is a two-way street It benefits not only the student but also the experienced planner or engineer NASA's advanced planning is becoming increasingly conservative and shortsighted A fresh approach to the complicated problems of future space programs could relight the flame of creativity that was so evident in the days of Von Braun

As NASA gets older, the agency becomes increasingly resistant to innovation and change—the classic symptom of terminal bureaucracy But unlike most federal bureaucracies, NASA recognizes its own problem Dr Robert Frosch NASA administrator, was quoted in a recent interview in *Business Week* "The system has now sharpened its pencils in a way that discourages changes that are major We have been so busy with other things that we have inadvertently told the people who think up ideas to go away'

Thus, NASA realizes it needs a transfusion of ideas, and the most obvious source for these ideas is the student community Students can contribute a different viewpoint, a fresh approach that the experienced eye may have overlooked Such involvement would prevent a loss of planning momentum, end perhaps end NASA's lack of creativity

The Space Age has passed its twenty-first birthday, NASA is twenty years old, and it s about time that government end industry realized that established engineers and scientists do not have a monopoly on creativity If the United Stetes is to maintain some semblance of cosmic leedership, it will take more than presidentiel rhetoric A serious ettempt to involve young people in all aspects of space—planning hardware development, and flight operations—is essential to the vitality of future space programs NASA's current expenditures on educational programs are minuscule and such funds are usually the first items to be cut during budget reductions Even under the President's tame space policy this state of affairs cannot be tolerated If we are to maintain our leadership in space, a substantial commitment to e youthful, creative space program must be made Failure to do so will mean Humankind's Childhood's End will never occur

Stan Kent, a young engineer now employed by Aerojet Liquid Rocket Company, is a member of the NASA advisory subcommittee on innovation

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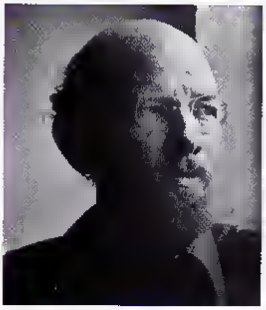
STUCKEY


EDGERTON


SOBEL


DURANT

Seventy-six-year-old *Harold 'Doc' Edgerton*—inventor of everything from Brownie flashcubes to laser strobes—is a folk hero among the world's top photographers and something of a legend around MIT, where he has been a professor for half a century. It was Edgerton who first introduced ultrahigh-speed photography, developed high-speed motion pictures, took the first films of atomic explosions and the first close-ups of the Loch Ness monster. This month *Omni* presents a profile of Edgerton by former *Rolling Stone* editor *Stephen Davis*. "I saw his photographs in the *National Geographic* when I was five years old," says Davis. "I've been a fan ever since. The images were burned into my mind." Davis spent a month with Doc, attending his classes and meeting with many of his colleagues. Another credit to the man, Davis says, "is that he's probably one of the most beloved men in scientific history." Davis's profile of this master illuminator begins on page 44.

"One of the reasons why we have never been given an accurate picture of an alien being's likely appearance," says author *Gene Bylinsky*, "is that no one has talked with the right people: it's the students of evolution and the biologists who are likely to be more rigorous in their research, not the astronomers and the physicists—with their assumptions of manlike creatures." In "Life in Darwin's Universe" (page 62), Bylinsky tries to fuse together biological and physiological methods to examine the probabilities and improbabilities of the appearance that alien beings are likely to take. What do beings on other planets look like? Well, you wouldn't want to go up and embrace one," Bylinsky remarks. Artist Wayne McLoughlin illustrates.

When *Omni* decided to profile the Bronx High School of Science in New York City, Washington editor *Bill Stuckey* jumped at the assignment. Stuckey has more than just a passing interest in the high school. He claims to know more about Nobel Prize winners than just about anybody else in the world, and Bronx just happens to be considered "*the* breeding ground" for future Nobel laureates. Stuckey rightly saw this as the perfect chance to meet some future prizewinners, as well as to pick up a top story. In his article "Saraswati in the Bronx" (page 90), Stuckey profiles Arani Bose, one of "Science"'s typical students whose brains and ability will probably shape the future—if he so chooses.

"I don't like punishment," says famed behaviorist *B. F. Skinner*. "One of the first tasks of behavioral science should be to find substitutes for traditional punitive methods." The professor discusses his ideas on behavior modification in an exclusive interview with *Omni*.

Skinner talks with writer *Michael Hollingshead* about planned communities, programmed education, and current American attitudes and conditions—what they could mean for the future—beginning on page 76.

In "Food for Zero-G," free-lance writer *Dava Sobel* informs us that space-shuttle crews won't revert to slurping out of plastic bags like their predecessors. "There'll be a fully operational galley on board, capable of preparing seven meals in just 23 minutes," writes Sobel. "At least, there'll be variety." Sobel's fondness for space travel and her interest in food led her to NASA's Johnson Space Flight Center in Houston, Texas, where she was introduced to some of the leading diet and food specialists. The highlight of her trip was sampling a bowl of dehydrated bananas." Sobel's cook's tour of outer space begins on page 98.

In 1971 *Lester Cooke*, curator of painting at the National Gallery of Art, in Washington, D.C., and NASA's *James Dean* authored a magnificent book, *Eyewitness to Space*, containing reproductions and prints representing NASA's art program. This volume is out of print now, however; original transparencies of a selection of these works were made available to *Omni* by *Frederick C. Durant III* for this month's pictorial (page 80). Durant is assistant director for astronautics at the National Air and Space Museum. Dozens of these fine works are on continuing exhibit at the museum, in Washington, D.C.

And back for a second time is underwater photographer *Douglas Faulkner*, who in the May issue of *Omni* brought us "The Universe Below." This month Faulkner offers "Geoscapes," on page 56.

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SEPTEMBER

LETTERS

COMMUNICATIONS

Boundaries of Space

I was surprised to find in the space law article by Dr. George S. Robinson ["The Matter of Space Law," June 1979] no mention of the most basic loose end in current space agreements—the definition of the near-earth boundary of space. To date there have been no explicit agreements on where sovereign air space controlled by each nation as it is able, ends and the international arena called space begins. Since all space treaties are relevant only in space, this unresolved question leaves the danger that as nations become better able to control overhead space traffic, nationalism will disrupt the best-laid plans of the United Nations and others. The 1976 Declaration of Bogota is a perfect example of how this ambiguity can influence the thinking of nations not favored by the current treaties.

Steven J. Sloboda
Green Mountain Falls, Colo.

Garlic Power

Thank you for the little article about garlic [Continuum, May 1979]. I, for one, really enjoy these dabs of information presented as human interest.

Two things that might be of interest to your readers about garlic: 1) it need not be smelly if taken in pill form with parsley; 2) it is also very helpful in forcing worms and other parasites out of the body's system. Studies by HEW have shown that a surprisingly high percentage of people, both urban and rural dwellers, are hosts to intestinal parasites. With this in mind, more people ought to take the powers of garlic more seriously.

Scott Evan Gershen
Santa Fe, N. Mex.

Your Continuum article on garlic reminded me that a week or two before I read it I had heard a chef on a local talk show relate how he had prepared an ancient Roman meal according to surviving documents. He found the meal unbearably salty. According to him, one of the first signs of acute lead poisoning is an inability to taste salt. The chef said that many Romans were suffering from this kind of poisoning because of the lead present in the glaze of the containers and in the pipes that were in use at that time.

If garlic does indeed remove lead from the body, then it could really have been a strength inducement way back then.

Joe Morgan
Bridgeton, Mo.

Comrades in Orbit

I refer to James Oberg's article "Red Star in Orbit" [May 1979] and the Soviet Union's rapid development of space-colonization capabilities.

Why couldn't this be used as an arena for collaborative efforts between the United States and the USSR? Since the two nations seem to be concentrating their attention on different aspects of the overall "space effort," it would be a practical as well as a humanistic goal. How about American shuttlecraft delivering astro/cosmonauts to orbiting Russian-built stations where research could be carried out cooperatively for the benefit of all mankind? It might even set in motion a new era for international brotherhood, which could make further hostilities and global warfare unthinkable. Well, maybe that would be too much to hope for in the near future. At any rate, if the practical advantages are there, let's pursue them. I think we're all sick of hearing about the continuing 'space race.' What purpose does it serve? More important, who needs it?

Robert East
Chapel Hill, N.C.

Political Scientist

I wondered whether a scientist could be a politician (or vice versa) until I read the interview with Frank Press in your June issue. Now that I know our President can make immediate decisions on technical matters after only a "very few words" of explanation and that his technical adviser knows the laws of physics well enough to realize interstellar travel is "enormously difficult, if not impossible," I no longer wonder. Now I know he can't.

Tim Newlin
Keyser, W. Va.

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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, N.Y. 10022.*

Paper Mills

Referring to *Omni*'s interview with Frank Press [June 1979]: Could it be that our adversaries in the space race actually have their scientists and engineers engaged in professional research, instead of writing proposals, accounting, or filling out government forms? There is a huge untilled demand, Dr. Press says. Perhaps, but if he had gotten out of college anywhere from 1970 to 1975, I suspect that prospective employers would have told him, with his credentials, that he was overqualified for present openings.

I doubt that any scientist is penalized for overqualification in the USSR. There it is recognized that one of the very few government programs that will pay for itself in the long run is to get every qualified scientist, physicist, and engineer into the basic research that is the key to new technology.

Maybe the only hope is that our adversaries will prematurely accomplish the equivalent of another *Sputnik* and frighten us back into full utilization of our scientific manpower.

James R. Bruce
Point Pleasant, N.J.

Dragonian Physics

"Flight of the Dragon" [June 1979], by Peter Dickinson, was great. I read it three times and talked about it for many days.

I have a few quibbles, however.

I think the author was wrong as to what type of gas formerly provided lift for dragons. It would have been methane, not hydrogen. All herbivorous animals produce methane in their stomachs. Ten cows produce enough to supply the energy needs of an average family. A dinosaur would have produced many times that amount. Large animals have a problem in getting rid of their body heat, some dinosaurs evolved bony plates along their backs to release heat, but dragons could simply have vented the excess heat into their internal methane sacs. During the early stages of their evolution, methane provided dragons with buoyancy in shallow seas. A dragon could beat its little wings and skim across the surface like an airboat, eventually it evolved the ability to rise into the air like a hot-air balloon.

Dickinson is correct in saying that a dragon had to belch gas in order to descend, but he didn't have to imagine a method of igniting the gas. Methane often ignites spontaneously in marshes. That marsh gas has moved at high speeds in the upper atmosphere might be attributable to high-flying dragons.

The author writes that dragons were carnivorous, but their herbivorous nature is demonstrated by the fact that they never ate the high-born young women they captured. They simply kept them as pets.

It is true that a punctured dragon could not fly, but this did not necessarily mean it died. If a grounded dragon could crawl to a deep lake and submerge itself, it could subsist indefinitely on underwater vegetation. Some dragons may have survived on lake bottoms to this very day.

Eugene Marquis
James Park, B.C., Canada

Stopgap Comparisons

Ben Bova has got to be kidding! Has he done a cost-analysis comparison between so-called soft-energy technology and building, equipping, manning, and operating a nuclear-power plant complete with zero-defect construction? There are also the problems of training operators and constructing rockets to fly the wastes into space. If one compares the hazards of coal and liquefied natural gas [LNG] with radioactive contamination, the fossil fuels have a hazard range based on one-time, short-term exposure and then the threat is gone. With radiation, as Bova says, the wastes will be "dangerously radioactive not *merely* for centuries but for millennia."

Enough of stopgap measures, especially when the item in question is the most dangerous and most terrifying energy alternative imaginable. For once, let's do the right thing the first time. Let's apply the incredible amount of money that Bova advocates spending on nuclear energy toward the utilization of free, safe energy sources.

Ryan Moses
Santa Barbara, Calif.

Ben Bova replies: *Why must it be either-or? Nuclear energy is here now, solar- and other soft-energy technologies are at least a decade away. Let's spend the money necessary to train the people who operate nuclear power plants to the point where their competency is equal to their responsibility. It actually would not take that much money, training people is cheap, compared to the cost of the power plants they operate. The plants themselves are built well enough to be very safe. It's the performances of the people that need upgrading. And in the meantime we should also be pushing toward other energy sources, even though none of them are as 'free' as you seem to think.*

The Hunt

In attacking opponents of the Newfoundland seal hunt, Daniel D. Horsman [Forum, June 1979] falls into a number of traps common to many seal-hunt supporters. His suggestion that

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THE BONE HUNTER

EARTH

By Kenneth Brower

Loren Eiseley, who died two years ago, had a following that was larger than a cult but never quite the horde he deserved. He was a writer whose work might be right, I suspect, for many readers of this magazine. Eiseley was a citizen first of this planet, second of the universe. His attention ranged widely, bouncing between the fossiliferous strata of the Oligocene and the outer reaches of the galaxy. His ascents to the stars were less frequent and less enduring than his descents into stone. If his mind's eye had a mean annual elevation, it was somewhere just outside the troposphere.

Eiseley made sorties into the future, but most of his journeys were into the past. He often traveled in both directions simultaneously—a prerogative reserved for students of evolution like himself. If any single epoch had a hold on him, it was the Pleistocene. He spent much of his time there, in the company of mastodons and ape-men. He was capable, though, of abrupt departures. The one cinematic reference I can recall in his work is to Stanley Kubrick's *2001*, and the scene that struck him was that stunning transition where the bone club, tossed into the sky by a protohominid, comes down as a space station. Kubrick's notion there is as Eiseleyesque as anything that Eiseley himself ever tried.

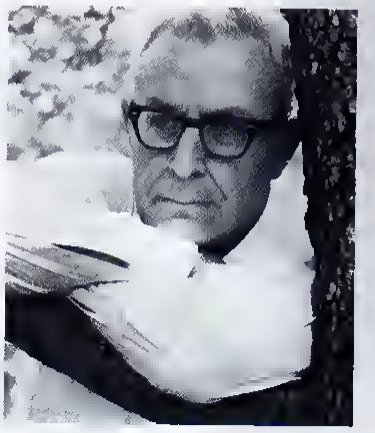
The following is an invitation to discover Eiseley, if you haven't done so already.

In 1965 I met the poet-naturalist in the flesh. My father, David Brower, and I sat in Eiseley's office at the University of Pennsylvania, trying to persuade him to go to the Galápagos Islands. In the 18 volumes then completed in my father's "exhibit-format" series of photographic books, and in the 12 we have done since, Eiseley has been a prime source of quotation. We've ransacked him more thoroughly than any writer except, perhaps, Thoreau. Eiseley did not mind, and he had agreed to write the introduction to our Galápagos book. That should have been coup enough, I suppose. It was my idea, though, that Eiseley should go in person to the islands.

Eiseley was at his best, it seemed to me, when he was playing Hamlet to some sort of Yorick's skull.

As in the opening passages of *The Immense Journey*, his book on evolution: "I squatted on my heels in the narrow ravine and we stared a little blankly at each other, the skull and I. There were marks of generalized primitiveness in that low, pinched braincase and grinning jaw. . . . It was the face of a creature who had spent his days following his nose, who was led by instinct rather than memory and whose power of choice was very small. . . . The skull lay tilted in such a manner that it stared, sightless, up at me as though I, too, were already caught a few feet above him in the strata and, in my turn, were staring upward at that strip of sky which ages were carrying farther away from me, beneath the tumbling debris of falling mountains. The creature had never lived to see a man, and I, what was it I was never going to see?"

For his leaps into abstraction, Eiseley liked to push off from something small, hard, and particular. He was an anthropo/archaeo/bioliterary Aladdin good at finding something in the sand, rubbing it, and summoning forth its genie. I thought he should have the opportunity to lay his hand on the cool, lithic hardness of a Galápagos tortoise's shell, as a touchstone for his meditations, or to run his fingers over the scales of a marine iguana for whatever tactile messages the Age of Reptiles might send him. As we made our appeal, I was watching Eiseley's eyes, and I think we almost had him. Then he remembered his many obligations. Several months in the Galápagos was impossible. He firmly refused.



Citizen of the universe Loren Eiseley

Dr. Eiseley's office was the spacious, well-appointed suite of a professor whom the university very much wanted to keep. I remember bones and stones on the desks and shelves, as I had expected. I remember lots of books. But I recall Eiseley's appurtenances less well than his voice. It was deep and resonant, the delivery unbelievably slow. I have never met anyone who spoke with more deliberation. His facial expressions were minimal, slow to surface, slow to subside. It was as if the models for his behavior were not from society, or even from biology, but from geology.

As he spoke of his obligations, sounding like a man with the weight of the world on his shoulders, I remembered that he was an insomniac. I was annoyed just the same by the Atlas pose. (I was a third his age, entirely free of obligations, and I slept like a log.) His weighty sentences, bumping each other like tectonic plates, tired me out.

The black-and-white portraits of Eiseley on his book jackets are revealing. First there is the face itself. Eiseley looks like Moses, or like an Easter Island monolith. The features are strong, deeply chiseled, august, and grave—almost as if his visage were trying to become like the stones that his big hands had spent a career digging in. Not once does Eiseley face the camera. He is always gazing off, like the poet at the picnic, except with Eiseley there is no picnic. Not once does he smile. His mouth is turned permanently downward at the corners, not in melancholy necessarily, but with that grimness sometimes attributed to desert rocks—a grimness of aspect that may or may not hide an interior grimness.

Then there are Eiseley's poses. All are

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SPACE

By Mark R. Chartrand III

Turn off your lights, turn on to astronomy proclaims a bumper sticker distributed by the Astronomical Society of the Pacific. But amateur astronomers aren't the only ones concerned about the serious problem of light pollution of the dark night skies.

Skies were dark before urban sprawl and the automobile came to dominate our society. Today such pioneering observatories as Mount Wilson near Los Angeles, Lick near San Jose, and even Kitt Peak National Observatory near Tucson, are continually fighting an uphill battle against increasing light levels. The venerable Greenwich Observatory has become a museum. Since Greenwich is now a suburb of London, serious observing is carried on at a distant field station.

There is no simple solution for this problem, because the light is a result of attempts to make streets and highways safer, to light outdoor patios, to sell cars in outdoor lots, and for myriad other necessary human activities. But the result is that the skies are not what they used to be.

Ironically, the increase in light has been accompanied by a growing interest on the part of astronomers in exploring fainter objects and by a technological improvement in our ability to detect faint objects. The artificial skylight seriously hinders these delicate observations.

Astrophysicists rely on spectroscopy—breaking light into its component colors—to deduce the properties of distant stars and galaxies. Modern attempts to save energy on Earth have produced new light sources that are more efficient but that produce much of their light in the color patterns most critical for astronomers, because of similar color patterns astrophysicists can't always determine what they're looking at. As Murphy's Law would have it, lamps that are the best for society are the worst for astronomy.

Even if there were no artificial lights, and even if there were no moonlight, the night sky would not be completely dark. Just hold up a piece of black paper some night and compare its brightness—or darkness—with that of the sky. The paper will be blacker by far.

This ever-present light comes from several sources. The most important is zodiacal light: sunlight scattered back to Earth by tiny dust grains that float in the solar system close to the plane of Earth's orbit. From a dark location you can see some of this zodiacal light as a faint triangular glow along the horizon around the time of sunrise or sunset. In very dark regions you may be able to trace the glow all the way around the sky and notice a slightly brighter patch directly opposite the sun. This is the gegenschein, or counterglow, caused by the dust's tendency to reflect light directly back toward the sun.

Another component of the night sky is the spread-out light of the stars; astronomers call it integrated starlight. If all the starlight were spread evenly over the sky, it would be equivalent to having one star, just at the limit of visibility, for every square degree of the sky. Put another way, the light from all the stars would be equal to the combined light of 51 stars as bright as Sirius, the brightest in the sky. Its current diffusiveness, however, presents a challenge to astronomers.

A third component of skylight is called airglow. This is a faint light produced by chemical reactions high in the atmosphere. When energetic solar particles are captured by Earth's magnetic field, they strike atoms and molecules in the air, exciting them to glow. This is the famous *aurora* (often mistakenly translated as "dawn") that causes a spectacular show in middle and upper latitudes. Even when auroral displays are not visible, a slight glow can be seen.

A small contribution is also made by the light of distant stars and galaxies that has been scattered around the sky by the gas and dust in interstellar space.

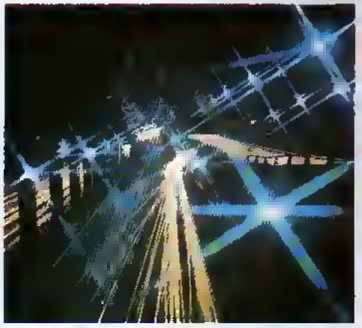
We can't do anything about these effects, and astronomers are used to living with them. But the increase in man-made illumination and in atmospheric pollution by gases and dust is putting some observatories out of business.

To appreciate the effects of light and atmospheric pollution, recall what it is like to drive down a highway with a dusty windshield. The more dirt on the glass, the more the light of an approaching car obscures your vision when it hits the windshield. The brighter the lights, the harder it is to see faint objects at the side of the road.

Things can be done to reduce the problem. Sometimes the offending colors can be filtered out. The observatories near Tucson got the city council to pass an ordinance requiring shields on all outdoor lamps, to prevent the light from shining upward. The Batelle Observatory, near Richland, Washington, persuaded the city not to install certain types of sodium-vapor lamps which emit light at wavelengths especially detrimental to their work.

These efforts are just delaying tactics, though, for the use of artificial lighting will continue to grow. Astronomers are aghast at the suggestion by some police officials that we place huge mirrors in orbit to illuminate cities at night in the hope of reducing crime. Lurking over the horizon is the possibility that in a couple of decades dozens, perhaps eventually hundreds, of solar-power satellites will enter orbit. Each will be twice as bright as the planet Venus ever becomes.

By then, however, the same technology that put power stations in orbit may provide the solution: observatories on the moon or in space, away from even the airglow of Earth. It's a possibility not to be taken lightly.



Highway glare is one source of light pollution now making orbiting space observatories essential

MICROBE MINERS

LIFE

By Dr. Bernard Dixon

Mining for metals must be one of the filthiest activities associated with "civilization." People who work in this industry face health hazards and working conditions at least as bad as those in coal mining. Smelting and chemical-extraction plants are environmental insults to populated areas nearby, and the heaps of waste form ugly blots on our landscape.

Imagine a new technology that would abolish all the negative aspects of mining and that would do so by exploiting something that, elsewhere, is responsible for some of the worst forms of pollution in rivers and lakes. This could be done by using bacteria capable of living in conditions normally considered extremely hostile to life. Then contemplate the advance of such bizarre technology in just a few years, from theoretical speculation to big business.

This is the story of microbial mining. In little more than a decade, the recondite ability certain bacteria possess to leach metals out of ores has been turned from odd textbook knowledge into a burgeoning industry in Canada and other countries.

The microorganism at center stage is *Thiobacillus ferroxidans*, a primitive life form that may have been one of the earliest to inhabit the earth. It thrives by oxidizing pyrites and making soluble the iron and the copper they contain. When it works on the leftover wastes from conventional mining, the bacillus causes considerable pollution in mines and in effluent waters from dumps. But harness this skill and you have a potent method of extracting those same metals from low-grade and inaccessible ores. Although pyrites are virtually insoluble, this humble bacillus increases the dissolution rate a million times. The metal itself can then be released from solution by one of several simple techniques.

A typical application, as pioneered in the United States by Rio Tinto, is heap leaching. Pieces of ore are simply placed on an impervious surface and sprayed with water. There's no need to add *T. ferroxidans*; it will be there already. The bacteria promote a variety of chemical reactions, solubilizing iron and copper and generating sulfuric acid. Copper, for example, appears as copper sulfate. There are several ways of recovering the metals afterward. One of the easiest is cementation, in which copper-rich waters are circulated over bits of iron and can be scraped off from time to time.

The Western Mining Corporation in Australia has announced a microbiological method for extracting another valuable metal, nickel, from low-grade ores. The rock is sprayed with a diluted solution of sulfuric acid containing *T. ferroxidans*. Percolating through the ore, the liquid extracts high concentrations of nickel, which in this case is removed from solution by electrolysis. In the USSR, researchers at the Irkutsk Institute of Rare Metals have claimed similar success in microbial mining for gold.

Uranium leaching is even more promising, in view of the rapidly escalating cost of this metal and the ease with which bacteria scavenge it from the most unpromising materials. Although most uranium is extracted with chemicals, less rich ores are already being treated with microbes. Now a massive shift toward microbial methods is apparent throughout the industry. Work at the Elliot Lake area in Canada is typical. About 30 percent of the ore there is left behind to support the roof of the workings. Afterward, water is pumped down, *T. ferroxidans* begins work, and, eventually, over 90 percent of the residual uranium dissolves.

Taking this a stage further, mining engineers are beginning to see microbial mining as a total replacement for orthodox techniques. Water containing the mini-miners can be pumped into deep rocks and then can be brought back to the surface for metal recovery. Miners' lives are not put at risk, damage to the environment is negligible, and there are enormous savings in transporting, crushing, and grinding the ore.

In a book of mine published only three years ago (*Magnificent Microbes*, Atheneum), I wrote keenly but cautiously about future prospects for microbial mining. The rest of that book remains highly topical. But its assessment of the surprising application of bacterial talent has been quickly overtaken by events. Rarely can a science writer see an enthusiasm so rapidly outdated—or be so delighted that this should happen.

Copper ore dissolved in water by microbes is circulated over iron bits to extract pure copper

THE ARTS

By James Delson

Time travel has generally been ill used in motion pictures. After enduring such embarrassments as *Manhunt of Mystery Island*, *Terror from the Year 5000*, and *The Three Stooges Meet Hercules*, I think that time travel has rarely been exploited beyond its obvious use as a device to get fictional characters from point to point and perhaps bring them back again. Having "arrived" in another time period, characters spend the remainder of their adventure coping with—not relating to—their strange new surroundings.

To date, the best time-travel film is *The Time Machine* (1960), produced and directed by George Pal. A pioneer in the factually based science-fiction film, Pal almost single-handedly launched the science-fiction film craze of the 1950s. His subject matter in the pictures preceding *The Time Machine* ranged from voyages of discovery (*Destination Moon*, *The Conquest of Space*) to alien invasion (*War of the Worlds*) to the forcible evacuation of Earth by spaceship (*When Worlds Collide*); these endeavors won him an Academy Award for special effects every time he made a movie during the Fifties.

The Time Machine was his crowning achievement, the zenith of a career that spanned five decades. Though badly dated now because of such unforeseen happenings as the women's liberation movement and the technological breakthroughs in special effects, it still remains a box-office draw. In Paris last March for the eighth International Paris Festival of Fantasy and Science-Fiction Films, I went to see *The Time Machine*, which was revived at a theater that usually screens first-run films. No longer able to satisfy a mass audience, *The Time Machine* endures as a classic children's fantasy.

Largely by default, Pal's film remained the yardstick against which all time-travel pictures were measured for 20 years. But Warner Brothers' *Time After Time*, which is being released this month, stands a good chance of displacing *The Time Machine* as the leader in the genre.

Time After Time was written and directed by Nicholas Meyer, the best-selling author and Academy Award–nominated screenwriter of *The Seven Percent Solution*. Like William and James Goldman, whose pseudohistorical stories, such as *Butch Cassidy and the Sundance Kid* and *The Lion in Winter*, have delighted audiences for years, Meyer is an ace purveyor of creative anachronism. In his first directorial undertaking, he uses the chase-mystery form that served him so well in *Solution* to set H. G. Wells hot on the trail of Jack the Ripper.

Time After Time relies heavily on the device that transports characters through the passages of time from Victorian London to present-day San Francisco. "I had complete freedom to do as I wished in creating our time machine," Meyer explained. "But in coming up with the design I imposed three restrictions of my own. First, it had to be enclosed, as opposed to the open-sled design used by George Pal; second, it had to look improvised, as if Wells could have built it himself; finally, it had to be Victorian. I told our production designer, Edward Carfagno, that I wanted a miniversion of the submarine from Disney's *20,000 Leagues Under the Sea*, and the result was just right."

It looked fine, but there was a problem in the back of my head about what sort of power it used in order to travel. This was solved when Carfagno suggested solar energy, which had been used to power a printing press as early as the eighteenth century. Carfagno put a catching dish on the machine, and it worked fantastically. I even added a line mentioning the French engineer who had first come up with the printing press."

Ironically, one of the major problems with films that employ time travel is that they date so badly. Even the Victorian sequences in *The Time Machine* have a distinctly Hollywood 1950s look. To most filmmakers, the problem is of little importance. They set out to make pictures with which current audiences can identify, not enduring works of "artistic" merit. Therefore, they include the latest styles in hair, makeup, clothes, and speech, as well as references to current events or figures

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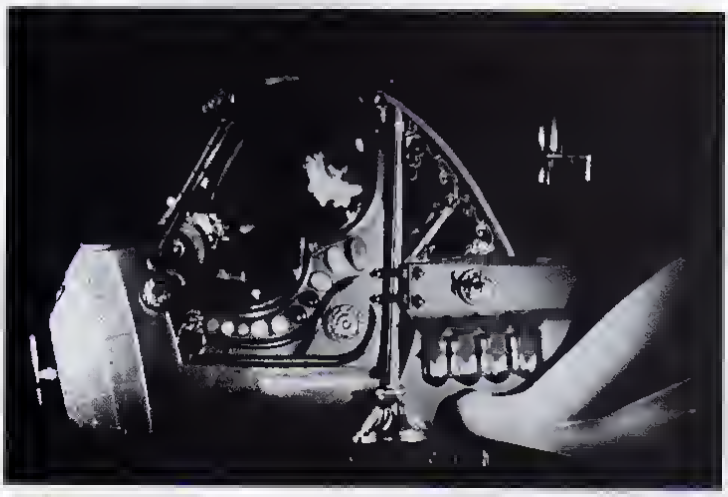

Characters go from Victorian London to present-day San Francisco in Meyer's Time After Time

TELEVISION

THE ARTS

By James Delson

Science and science fiction programming on English television is an odd mix of American action shows, British-made documentaries, and a hybrid of both types called *Tales of the Unexpected*. Last spring one could have seen numerous U.S.-produced episodes of *Superman*, *Batman*, *Spiderman*, *Wonder Woman*, *The Bionic Woman*, *The Adventures of Captain Nemo*, *Salvage-One*, and *Mork and Mindy*, only the last two of which are still in production. Supplementing these relatively unsophisticated programs are the excellent, literate English documentary series *Horizon*, *Life on Earth*, *The Long Search*, *Worlds Without Sun*, and *Beyond the Moon*, as well as fascinating individual studies on such subjects as the nature of time, the Turin Shroud, and cloning. But the surprise hit of the season was *Tales of the Unexpected*, a series of 24 half-hour adaptations of writer Roald Dahl's short stories.

Although not as informative as *Horizon*, the British equivalent of Public Broadcasting Service's *Nova*, or as historically important as *Life on Earth*, a 13-part history of evolution that ranks with *The Ascent of Man* as an educational document, *Tales of the Unexpected* is both artistically pleasing and commercially successful. Unlike most British series, it has been picked up for American commercial syndication beginning this month.

I met with John Rosenberg, producer of dramatic programming for Anglia Television, one of Britain's "minor" networks, and the production company of *Tales of the Unexpected*. Sitting in his spartan office, which overlooks London's Hyde Park, we sipped afternoon tea and talked about this series as well as some of the other projects he has been involved with in his term at the network.

"I was MGM's representative in England for some years before I became associated with Sir John Woolf, one of the most distinguished English film producers of the postwar period. His films include *Room at the Top*, *The African Queen*, *Oliver!*, and *Day of the Jackal*, and I've been with him for the past fifteen years. I was gradually drawn from feature films into television production as he became one of the executive directors of Anglia. One thing led to another, and for the last few years I've produced all their drama.

"Looking back over the things I've done, the film that stands out most was a fictionalized documentary called *Alternative Three*. It was about the conspiracy of several governments on Earth to plant survival colonies on Mars. We showed very scientifically and realistically that the ecology of the earth's environment was gradually ceasing to support life. The film caused a great furor over here. In fact, the networks were rather scared of it. I've never had such a response from the audience. All the telephone lines were jammed, and it proved to be a very worthwhile experience for me because I myself spoke to so many people about the program. The Americans were going to buy it but then didn't, fearing I would think another Orson Welles/*War of the Worlds* incident.

Sir John Gielgud in Tales of the Unexpected

"One of the other shows I'm particularly happy with is *The Atom Spies*, about the British scientists who passed atomic secrets on to the Russians. Quite a different thing was *Betsy*, a lovely little piece about Napoleon's last year on St. Helena and his love for the daughter of the island's British East India Company representative. In addition, I had the pleasure of producing two series of a very successful light comedy called *Back to the Land*, about the 'Land Girls,' women who were conscripted to work on farms during the last war. I've been working on the Dahl shows for the better part of the last two years.

"*Tales of the Unexpected* came into being because Sir John Woolf and I were very interested in the work of Roald Dahl. Although a few of his stories were televised by Hitchcock in the Fifties, including the episode presented here, entitled *Lamb to the Slaughter*, no one had ever done a whole anthology of them before. They lend themselves peculiarly well to television because of the economic way in which they are written. [Dahl] creates characters and stories in a kind of shorthand. When you read them, you have to be pretty quick-witted to grasp what's coming next, what his people are doing, and why they're doing it. Motive is subtle and often surprising. All these things were intriguing. We thought that something worthwhile could be made of them.

"One of the first decisions we had to make was whether to produce the stories as hours or half-hours. This is always a question with anthology series, and with short stories in particular. Given the type of stories they are and the awful problems that resulted in the past when they were extended beyond their depth, we decided to go for compression, the quick conveying of information and character in the conception of the stories themselves. So it may be, in some cases, that we are too tight, but on balance, I think it's much better to leave your viewers wanting more than to have them think the show went on a little too long.

"We shall produce a total of twenty-four programs. The first nine have been

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THE ARTS

By Stephen Demorest

I dislike producers intensely I can hear the limiters slipped in I can hear the E Q [equalization quotient] tweaked up This is the tyranny of the professionals There's no room for mistakes to happen

Thus spake Robert Fripp, producer of the highly acclaimed Roche sisters album In recent years Fripp has done a modest bit of producing himself albums of art rock (Peter Gabriel) blue-eyed soul (Daryl Hall) and collaborations with fellow aestheticians David Bowie and Brian Eno He's had a healthy exposure to the most advanced elements of recording technology and in the process he has made a bold departure once again from the status quo in pop music

"The records most people make now are very polished " he asserts "but they lack the asperity of Beatles and [Jimi] Hendrix albums Instead of making records that tell people how we are we seem to give a more and more false, sterilized deodorized impression I personally think the trend toward aural exciters [devices that fatten each note with a millisecond-delayed echo] has more to do with people going deaf from standing in front of stage monitors too long "

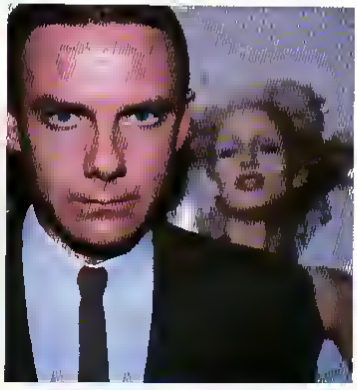
The radical guitarist becomes the archconservative of the electronic revolution? At first glance it might seem so In the 1970s Fripp of King Crimson was the most progressive band leader in rock and roll He almost single-handedly popularized the synthetic keyboard sound with his Mellotron and he transformed song composition to fit this new instrument Many consider Fripp to be rock s most accomplished guitar technician, picking up where Hendrix left off in the explorations of scorching solid-state effects As one critic commented he s able, "through a combination of electronics and superhumanly refined technique to make a guitar sound like a violin, a flute a wailing banshee—anything *but* a guitar" Yet his equipment setup has become very simple At night in New York s avant-garde clubs you can find him a lone figure on stage creating a dazzling assortment of "found' sounds via guitar and tapeloop

Robert Fripp is no reactionary hearkening back to the days of acoustic ballads but perhaps rather a sort of musical physicist looking for more basic acoustic quanta State-of-the-art machinery has so overwhelmed recording techniques that musicians have begun to feel that the sophistication of these gadgets threatens their individuality (In disco, for example, the song's production mayonnaise has become its true message its singer remaining unknown in most cases)

Consequently just as painters like Picasso and Braque abandoned representational virtuosity for the seemingly primitive but powerful colors and forms of early Cubism Fripp and his peers are attempting to recover an elemental force in music by emphasizing the essentials "You don t have to fill in all the details You simply have to indicate the most important points and anyone with any intelligence will fill in the rest himself

"I don t do anything complicated " he claims "The complication springs from the details involved The best approach is to conceal the art And the best example of that is the Roches' album Technically it s the nearest to perfection I ve ever come The production is incredibly sophisticated, but it doesn t show at all"

Fripp s aim was to capture the immediacy of the three sisters' live performance,



Fripp an intelligent self-contained mobile unit

and his "supreme validation" came when a passerby at Warner Brothers (the Roches record label) mistook the record for a live audition "There s precious little gilding of the lily " he says of the production he s termed audio *verite*

"I simply record what s going on without the imposition of format thinking For example Suzzy Roche sang one note that was completely off-key and she didn t like it But I felt she d subconsciously picked exactly the right note for the particular anguish required of that word If she d sung it on pitch, there would be no agony Another suggestion was that since we had three essentially acoustic singers with acoustic guitars we should put them with an electric-rock rhythm section I said no—it s like suggesting Leonardo repaint the *Mona Lisa* with blond hair and bigger breasts I leave what is recorded flat as far as possible

"The Roches' album is an album of perspectives, and one of the main approaches was the abandonment of center If you make a stereo record to get a radio hit you mix everything to cluster around the middle, within a certain frequency band so it will jump out of one tiny car speaker with the strength of mono This is absurd The Roches are subtle people and didn t need that kind of crass strength—to be loud in the middle I mixed the album so any point along a line from the left speaker to the right is equally valid as a listening perspective

"When the test pressing came along and the Roches played it against a Neil Young record they were most upset that it didn't have the same presence Of course it will not compete against any professionally produced album It's in a different class entirely Compared with the norm, it seems to lack the immediacy—it only seems to I say it doesn t" (Results? *Newsweek* praised the album's "spontaneity and sense of intimacy" and *The New York Times* in April was predicting it would stand as the best pop record of 1979)

Fripp s unorthodox approach also manifests itself on the trilogy of personal solo albums that he s in the process of releasing "I'm generally very happy to

CONTINUED ON PAGE 134

BOOKS

THE ARTS

By Eric Rosen

In his new book *The Politics of Energy* (Alfred A. Knopf, 1979), Dr. Barry Commoner offers his version of what has gone wrong with our energy policies. His analysis of President Carter's national energy plan is a stinging indictment of a plan that doesn't conserve energy but actually *increases* energy consumption over and above what Commoner, at least, feels is needed.

Dr. Commoner believes that a solution to our "energy crisis" can be brought about by a changeover in the resources we depend on for energy. Instead of relying on nonrenewable and capital-intensive sources (oil, natural gas, and nuclear energy), we should begin using renewable, environmentally benign resources (solar-based energies).

The energy crisis has not been caused by price increases demanded by OPEC, he asserts, but by a feature inherent in our patterns of energy exploration, production, and consumption. We have been forced to rely upon increasingly scarce resources—resources that have become more and more expensive to find and produce. This forces us into a never-ending cycle, a classic catch-22. It is this cycle, Commoner writes, that is the fundamental cause of our rate of inflation. The only way to solve both inflation and our energy woes is to go outside this cycle—to enter a transition era.

Commoner describes three theoretical renewable resources: solar-based energies, breeder-based nuclear (fission) power, and nuclear fusion. He dismisses fusion because it has not yet been achieved. (His first criterion for a transition fuel is that it be available today.) He also dismisses breeder-based nuclear energy, painting a picture of possible Harrisburgs, inadequate storage facilities, and the threat of weapons proliferation.

That leaves solar-based energies, and Commoner outlines his scenario for a transition based on solar power. He argues that most solar power is specifically suited for on-site, localized problems and does not lend itself to centralized, capital-intensive structures. The market already exists, or could be readily created, for solar photovoltaics, cogeneration of waste heats, wind power, hydropower, and the production of methane from biomass. He looks to the government to invest in solar technologies and thus provide the lead, as it has done in so many other industries (he cites integrated circuits as a recent example). With large-scale investments, costs would drop rapidly, creating new markets, further decreasing costs, and so on, until the technologies were found in all aspects of life.

In Commoner's opinion, the solution to the energy crisis is affordable and possible. His outline is a detailed one. He claims that if we do not follow this path, there will be little real economic growth in the future. To continue to grow and better our standard of living, we must enter the solar transition. He points out that the United States is in a situation similar to that just prior to the abolition of slavery—economic stagnation, a crisis in leadership, and dim prospects for the future. And, like the abolition of slavery, a transition to solar-based energies can be the catalyst for a new and different type of life and economy.

Commoner supplies his readers with a view that is almost a 180-degree opposite of what we generally read in the newspapers or see on the evening news. Whether or not his dream of a renewable economy will become reality depends, in large part, on how strong he makes his case to the public. *The Politics of Energy* is his attempt.

Scientists are commonly pictured as white-coated, ultraserious, and totally dedicated. They are usually all of these, and more. But most of all they are human, and it is their joy in being human, and their joy in life, that makes Horace Freeland Judson's *The Eighth Day of Creation* (Simon and Schuster, 1979) such a pleasure to read.

Judson spent seven years talking with, and learning from, the scientists who created the field of molecular biology. What he has come up with is nothing less than an authoritative history of molecular biology, a tribute to the scientists who solved some of the most fundamental riddles of life.

Judson compares the past 25 years in biology (roughly the time since James Watson and Francis Crick deduced the structure of DNA) to a similar period in physics more than 50 years ago, when the ideas of Einstein, Rutherford, and Heisenberg changed our concepts of the physical world. Molecular biologists, though, have changed the way in which we view life itself. The towering achievements of Watson, Crick, Jacques Monod, Max Perutz, and others have led us to the creation of new worlds—cloning and recombinant DNA, for instance.

All of the discoveries, Judson writes, took place "not by overturnings but by openings-up", that is, not by a grand revolution but by new ideas and concepts slowly emerging and being assimilated into current scientific thought. He writes in the introduction: "In the act of discovery, ideas and personal styles fuse."

Judson follows the scientists along each step of the way, showing us how they make their mistakes and then backtrack for the right answer. His narrative weaves in and out between different research centers and personalities with an ease and grace that is surprising, considering the complexity of the story he tells.

He concludes that the rise of molecular biology was due in large part to the fusion of several disparate fields—microbiology, genetics, biochemistry, crystallography, and physical chemistry. Ideas flowed from each field, and any research team worth its salt had to have someone well versed in each field close at hand. It is the fusion of concepts from these diverse fields that has led to our modern ideas of gene structure and function.

This is the triumph of the revolution in biology. One hesitates to suppose what the field of molecular biology would be like without this cross-fertilization of ideas. But what it *has* become is clearly outlined in *The Eighth Day of Creation*. For anyone looking for a primer in this field, for a look at scientific history in the making, or simply for an absorbing account of scientists at work, this is the place to start.

UFO UPDATE

By James Oberg

People who crave dogmatic certainties should avoid the UFO arena, whether they are believers or skeptics. Since it is the viewer not the UFO, who must identify any sighting, our less-than-perfect information flow virtually ensures that a small fraction of UFO appearances will never be explained. Despite this, there exists the distinct and never-disprovable possibility that UFO sightings are truly extraordinary, hitherto-unknown phenomena—and these are the possible pearls that UFO investigators have been seeking in a mountain of oysters.

However, as scientist Hudson Hoagland pointed out in *Science* in 1969, unexplained cases are not evidence for any theory. "The basic difficulty inherent in any investigation of phenomena such as those of UFOs," he writes, "is that it is impossible for science ever to prove a universal negative. There will be cases [that] remain unexplained because of lack of data, lack of repeatability, false reporting, wishful thinking, deluded observers, rumors, lies, and fraud. . . . Unexplained cases are simply unexplained. They can never constitute evidence for any hypothesis."

Even if all UFO reports were based on *explainable* occurrences, human perception, memory, and behavior would introduce an honest residue of completely unexplainable reports set off by ordinary but undiscoverable phenomena. Prominent UFO proponents reject the skeptic's attempt to lump the residual "true UFOs" into the "IFO" (identified flying object) column by assuming that the witnesses' perception and recollection were sloppy. True UFOs, they insist, are inherently different from IFOs, and this difference can be proved.

Dr. J. Allen Hynek, of the Center for UFO Studies (CUFOS), in Evanston, Illinois, is one leading researcher who believes entirely new theories are needed to account for unexplainable UFOs. "Experienced investigators quickly recognize IFOs for what they are," he wrote recently in his group's monthly newsletter, *International UFO Reporter*. "But sometimes it takes hard work to unmask the masquerader. . . ."

Reports published by Dr. Hynek's own research center suggest that the line between insoluble UFOs and trivial IFOs may not be as clear as he would like to think. Early in 1977, for example, Hynek's managing editor, Allan Hendry, published an editorial "to illustrate the thin veil that can exist between UFOs and IFOs." Describing his attempt to solve some nighttime UFO reports from Las Vegas, Nevada, on January 19, 1977, Hendry recounted a series of frustrating dead ends. Then, by "sheer luck," he stumbled on the bizarre explanation. The Environmental Protection Agency had been using an illuminated balloon on a half-mile tether to collect samples of air pollution. This was the object that had set off the reports, Hendry concluded confidently.

But without Hendry's lucky break, no amount of the hard work Hynek prescribes could ever have converted that UFO into an IFO. To be sure, without his persistence Hendry would never have had a shot at his luck. Hendry is considered one of the most hardworking and most diligent UFO researchers in the world; his reputation is confirmed by the low "UFO residue" statistics that CUFOS reports.

UFO spotted maneuvering above Japan, 1974

Yet not even the most skilled and diligent investigator can reduce the unexplained cases to zero. A good example of why such a residue will always exist is provided by an interesting case from California, reported in detail in the *International UFO Reporter* after superficial and sensationalized treatment elsewhere in the news media. It's called the Colusa UFO, or the Pecha (pronounced peck-ah) case.

UFO sightings have often inspired awe, curiosity, puzzlement, and excitement. They have also been known to incite terror. Whatever the original stimulus—and there are many IFOs among these cases—the fear that UFOs instill in some witnesses is all too real.

The primary witness in this case was a thirty-nine-year-old heavy-machine mechanic named Bill Pecha, who lives with his family in a mobile home on a farm 3.2 kilometers west of Colusa, California, northwest of Sacramento. Pecha's neighbors see him as calm, trustworthy, and strong, not easily frightened. It would take something extraordinary to scare him.

Shortly after midnight on September 10, 1976, Pecha's TV and air conditioner went off. Stepping outside to check the circuit breakers, he glanced up and saw a glowing, domed "flying saucer" filling the sky above his barn. Later Pecha estimated that the UFO, about 45 meters wide, was only 15 meters above the ground.

As soon as he stepped forward, the UFO retreated toward the west, covering about 60 meters in four or five minutes. Hendry's report reads: "The dome was vertically ribbed with concave sections like a lemon-juice squeezer. . . . Both the dome and its base had a dark silver-gray appearance, like porous slag. The upper body of the saucer was like porcelain, while the outer rim was like stainless steel. The rim was seen to rotate in a clockwise direction, in contrast to the central area of the white, flat underside, which rotated counterclockwise."

A large-diameter light source occupied the center of the underside, emitting a dim

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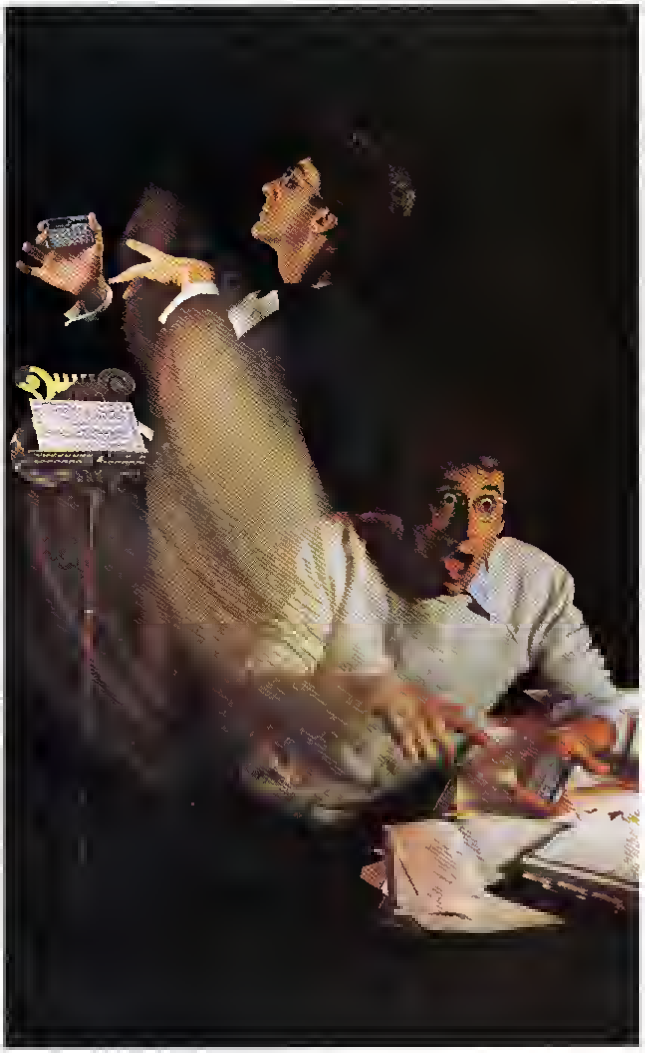
I'll bet I could charge admission.

ML-720 Music Card



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CONTINUUM

WONDER DRUG OR HORSE LINIMENT?

It was called the wonder drug of the Sixties. Cheap to make and easily available, it could treat everything from arthritis to mental retardation, according to its backers. Then the Food and Drug Administration (FDA) stepped in and the wonder drug of the Sixties became the horse liniment of the Seventies. Now, despite underwhelming FDA support, the drug, dimethyl sulfoxide, or DMSO for short, is making a comeback.

DMSO has a strange history filled with the elements of a political thriller: abrupt government bans, rumors of a cover-up, a high-level official suddenly "reassigned" to lesser duties, mystifying government investigations—all against a background of a "gray" market in drugs and phony sure-cure clinics in Mexico.

It began innocently enough in 1962, when Dr. Stanley W. Jacob, associate professor of surgery at the University of Oregon, heard about an industrial solvent, DMSO, that he could use as a kind of antifreeze to prevent cellular damage when deep-freezing kidneys for storage. Since the solvent was a cheap by-product of the wood-and-pulp industry, he got his samples from a paper company. Jacob made a few intriguing discoveries while working with the chemical. One was that the colorless, oily liquid was absorbed into his body with amazing speed. Within minutes of rubbing a little on his arm, he tasted the garlicky flavor of the drug in his mouth. Drugs mixed with DMSO had the same speedy permeability—a feature Dr. Jacob thought could be used to treat internal ailments and injuries.

He and others soon found that DMSO could be used to treat bursitis, arthritis, sinusitis, headaches and mild burns and that it had the ability to heal severe bruises literally overnight. An avalanche of experiments followed in which others claimed the drug worked on various cancers, skin conditions from shingles to acne, and even mental retardation. It was fantastic.

It was also dangerous, the FDA claimed. As evidence, the agency pointed to studies in which the lenses in the eyes of test animals clouded over after they were overdosed with DMSO. In 1965 the FDA banned any further human experimentation.

But by that time close to 100,000 people had already been treated with the drug and none had developed eye problems—a fact that made the ban a little hard to take. By the early Seventies the FDA had relaxed its position and approved DMSO as a prescription drug — for animals. Trainers rubbed it on their lame racehorses or greyhounds to get a few more miles out of them. But *people* also wanted the drug. So in defiance of FDA rulings, some doctors risked their licenses and prescribed DMSO for some patients, operating a "gray" market of drug treatments. DMSO clinics, some of them total frauds, opened up in Mexico for arthritic patients, making the drug a kind of laetrile for arthritis.

Finally in the spring of 1978 the FDA, after ten years of studies, approved DMSO in a weak concentration as a prescription drug for treating interstitial cystitis, a tormenting bladder problem in which the victim feels the constant need to urinate. This was the first time a banned substance ever made it back to "approved" status. But Dr. Jacob wants more. He and a small drug company named Research Industries Corporation are pushing the FDA to approve DMSO in stronger dosages.

The momentum of research with DMSO has also picked up. At the Cleveland Clinic doctors are testing the drug for a variety of ailments and diseases. Dr. Arthur L. Scherbel has had tremendous success helping victims of scleroderma, also known as hidebound disease. Dr. Carl Groppe, also at Cleveland, plans to mix DMSO with cancer-killing chemicals to speed up their action on severe breast cancers. National Cancer Institute researchers are trying a similar tactic on treating lung cancers.

Despite this rebirth of interest, the FDA did a mysterious thing in early 1979. It launched an investigation into its own approved research, claiming that researchers had covered up or ignored eye problems. It went after one doctor with a court order because he told FDA investigators he could talk to them only after hours. The investigators accused him of being uncooperative. Some of them even disturbed the man's patients by insinuating they might soon have eye problems as a result of taking DMSO. When Dr. K. C. Pani, the FDA's top DMSO expert, got wind of these tactics, he complained to his superiors. In response, they relieved him of his duties. In the end the agency found no evidence of a cover-up.

Today Dr. Jacob is worried. A personal believer in the drug, he told *Omni*, "I was very encouraged by the FDA until [that doctor] was harassed. I am not so encouraged now. I just don't think the atmosphere is favorable for DMSO." Depending on the government's next moves, DMSO may get that second chance to prove itself as a wonder drug—or become one of the most controversial horse liniments in history. —*DOUGLAS COLLIGAN*

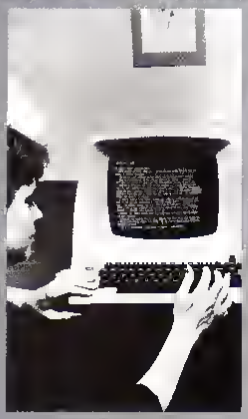
CONTINUUM

THE SOURCE

First there was The Force (in the movie *Star Wars*) Now there is "The Source the first information utility for your home

Want to know the latest news and weather? Your biorhythms? Need income-tax help? Airline reservations? And how about access to all United Press International news stories written in the past seven years? You can summon up this information and 2 000 other types, by using your phone to tap into the giant computers of the Telecomputing Corporation of America (TCA)

What you need is a home video-display terminal your telephone and a special coupler that uses the phone s headset to transmit and receive information from TCA A printer is optional depending on whether you want a hard copy of the data



The Source — access to 2 000 data bases for $2 75 per hour

The installation charge for the hookup is $100 The normal charge for the use of the system is $15 per hour But after 6 00 PM and up until 7 00 A.M the rate drops to $2 75 per hour

The Source can also be used as an electronic mail service sending and receiving messages nationwide

TCA leases home terminals to those who do not have their own You can contact TCA at 1616 Anderson Road McLean Virginia 22102 — Eric Rosen

COMPULSORY COMPUTING

If you can t program a computer you re nearly obsolete That s the clear message from Harvard

After nearly a decade of wrangling, the university has just revamped its core curriculum and the result won t soothe the future-shocked From now on not even a specialist in medieval French poetry will be able to graduate without passing basic computer courses

Another change Gone are the survey courses that once carried nonmajors painlessly through the sciences Even the most reluctant scholars must now take at least one science course that requires memorization — taxonomy say — and one that demands scientific reasoning

The new curriculum is expected to become a model for other schools

—Owen Davies

'Where there is no vision, the people perish

—Proverbs 29 18

BRAIN GRAFTS

Like skin grafts on a burn brain grafts may someday heal Parkinson s disease and other nerve disorders

Graft is thriving in rat brain nine months after transplant

Working with rats researchers at the National Institute of Mental Health have grafted working brain cells into damaged brains, thereby restoring normal function

The scientists, led by Dr Richard Wyatt destroyed part of the substantia nigra in the brains of a dozen male rats Dopamine produced by these cells helps control motor activity and its loss causes the equivalent of Parkinson s disease When such rats are given a drug called apomorphine they move involuntarily in an odd circular pattern — a reaction scientists say is equivalent to the tremors suffered by Parkinson s human victims

Nine of the rats were injected with the cells from the substantia nigra of healthy rats The cells were not transplanted into the damaged area but into a cavity closer to the caudate, an area associated with motor control where dopamine appears to work

A month later all the test animals showed at least some improvement Five of the rats showed a 70-percent decrease in circling when given apomorphine Three control animals, given cells from the sciatic nerve showed no improvement

After nine months none of the substantia-nigra grafts had been rejected. All had begun to send nerve fibers into the surrounding tissue and all were still counteracting the Parkinson's disease — like circling

The scientists are now working with monkeys but it will probably be a long time before the technique is used on humans So far, no one has been able to find an ethically acceptable source of human brain cells for transplant — O D.

"Of course behaviorism 'works So does torture Give me a no-nonsense, down-to earth behaviorist, a few drugs, and simple electrical appliances, and in six months I will have him reciting the Athanasian Creed in public "

—W H Auden

"The abolishment of pain in surgery is a chimera. Knife and pain are two words in surgery that must forever be associated "

—Dr Alfred Velpeau, 1839

QUAKE LIGHTS

For many years people have reported seeing strange lights in the skies before during and after an earthquake Dr John S Derr of the U S Geological Survey recently said that the existence of earthquake lights is now well established and that the subject should no longer be ignored

The lights are more pronounced in the middle of the shock Some people who have viewed them say they look like searchlights, others say they look like fireballs

Yutaka Yasui, of Japan, collected the only known photographs of earthquake lights (above) during the Matsushiro earthquake swarm in Japan, between 1965 and 1967 He claimed that at least 18 of the 35 sightings reported during that period could not be explained by known lights, such as meteors or twilight

The strongest illumination came during the earthquake that hit China in 1976 One seismologist reported that the lights at the center of the earthquake were bright enough to turn night into day Even up to 320 kilometers from the epicenter of the quake the lights were bright enough to wake people up thinking their room lights had been turned on

Experts have come up with two possible causes: violent low-level air oscillation and the piezoelectric effect in quartz-bearing rock If the second possibility proves to be the cause it may be possible to develop electrical monitoring methods for earthquake predictions—Tom R Kovach

Earthquake lights eerily illuminate sky in this rare photo taken during a series of small quakes and tremors in Japan between 1965 and 1967

"Things are more like they are now than they ever were before"
—Dwight D Eisenhower

ON MOTHERHOOD

The lion often saves its cubs from starvation by sharing its food after the lioness has either abandoned her litter or decided the cubs won't eat A study by George B Schaller, of the New York Zoological Society, has found that female lions are rotten mothers who often allow their cubs to die of hunger while they gorge themselves with food

Schaller also found that lionesses often forget about their cubs, moving on without them He once observed a lioness eating an entire 18-kilogram gazelle while refusing to let her litter eat

Lions, meanwhile, usually share their kills with the cubs Otherwise Schaller says "few cubs would survive" One reason for the behavior of lion mothers, researchers believe, is that a lioness can produce a new litter in four months if she misplaces her old one

—Stuart Diamond

Despite appearances, lionesses tend to make lousy mothers

SPACE MESSENGERS

Meteorites falling to Earth might furnish valuable information about how the earth and the rest of the solar system were formed A great collecting ground for these space messengers turns out to be frozen Antarctica, where everything can be found perfectly preserved Dr William A Cassidy of the University of Pittsburgh had a hunch Antarctica's frigid climate would be ideal for finding meteorites

In research funded by the National Science Foundation American and Japanese scientists last winter found 309 specimens, including two very rare carbon-bearing types and one weighing about 135 kilograms

Carbon-bearing meteorites "contain possibly the best records of conditions in the solar system at the time it was formed" some 4 5 billion years ago, Dr Cassidy says "The fact that amino acids are found in carbonaceous-chondrite material suggests that these compounds [were] formed in the original primordial cloud from which the sun planets and moons condensed"

The meteorite collection is being kept in moon-style storage equipment supplied by NASA —Alton Blakeslee

"It has taken the planet Earth 4 5 billion years to discover it is 4 5 billion years old"
—George Wald

CONTINUUM

OLYMPIC LIGHT WAVES

A radical new technology will help bring the Winter Olympics to your television screen. Hockey and figure-

Ice-arena events will be transmitted through tiny glass fibers

skating events will be broadcast in part via light signals transmitted through hair-thin fibers of glass.

The key to optical-fiber communication is the fiber itself. A 300-meter length is so transparent that it transmits about the same percentage of incident light as an ordinary window. A tiny laser made of a semiconductor compound generates the light signals. Another semiconductor device at the other end of the fiber changes the light signal back into electrical form.

This month New York Telephone will install a temporary fiber-optic system for the Winter Olympics in Lake Placid, New York. The system will carry television signals from the Olympic ice arena to a broadcast center serving 26 mass-media agencies.

Someday, if you have cable-television service, optical fibers may bring television signals right up to the back of your set. This winter, however, the signals from the Winter Olympics will travel only the first two miles of their way to your home on optical fibers. From the Lake Placid broadcast center, the signals will be transmitted by microwaves to the normal television-broadcasting system. —Jeff Hecht

A DEVICE FOR DIABETICS

An implantable device that simulates the function of the pancreas is expected to have a major impact on the control of diabetes. The device, known as the Andros Implantable Insulin Delivery System, is still in the experimental stage, but, according to George A. Shapiro, president of Andros, Incorporated, it has already proved functionally successful in preliminary tests on a dog at the Metabolic Research Unit of the University of California, San Francisco.

The insulin-delivery system consists of a tiny microprocessor, a power supply, a reservoir, and a small pump contained within a pocket watch–size unit that weighs only a few ounces. In humans the entire system would be implanted under the skin at a site yet to be determined by further anatomical study. Finely controlled amounts of insulin would be released by the unit at a preprogrammed rate, but the user could step up the dosage electronically before meals and during stress.

Once the system is implanted, the insulin supply would have to be replenished only every four to six months by a single injection through the skin into the self-sealing reservoir.

The current practice of treating diabetes by daily injections of insulin "cannot prevent blood-sugar levels from exceeding the critical point at which tissue damage occurs," says Dr. Peter H. Forsham, director of the Metabolic Research Unit and himself a diabetic. By overcoming this serious drawback, the new device which the developers feel will be ready for human use in three years, could extend the lives of millions of diabetics. —Kathleen McAuliffe

The Andros System is totally implanted beneath the skin

ESP AND Ph.D.s

There is a higher percentage of believers in ESP among college professors than among the general public. That's the surprising conclusion of a recent survey conducted by Mahlon W. Wagner, a psychology professor and researcher, Mary Monnet, both from the State University of New York at Oswego.

Of the 1,100 professors surveyed, two thirds—mostly those in the arts, humanities, and education—had positive attitudes toward extrasensory perception. A recent Gallup poll found that only half of the Americans interviewed were favorably inclined toward parapsychology.

The only thing the professors had reservations about was the notion of plants and animals having ESP. Those who were skeptical were mostly in the social sciences. And the majority of those showing outright hostility to the idea of ESP were psychologists.

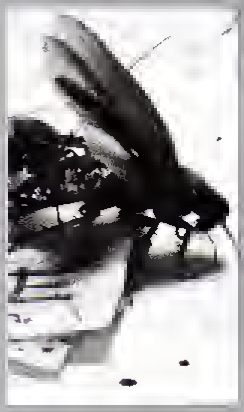
Wagner and Monnet suggest that psychologists, who are actually better read on ESP than many of their colleagues in other fields, are not satisfied with the design of many of the experiments used in parapsychology.

Wagner and Monnet's study will be published in the October issue of *Zetetic Scholar*. —Douglas Colligan

"If the human brain were so simple that we could understand it, we would be so simple that we couldn't."
—Lyall Watson

EAU DE ROACH

After 30 years of trying, an international team of scientists has finally come up with a perfume that no healthy,



Male roaches go wild when exposed to female sex pheromone

hot-blooded male cockroach can resist.

It's a totally synthetic copy of periplanone B, the sex attractant exuded by the female *Periplaneta americana*, better known as the American cockroach. The synthetic was developed through the cooperation of a very patient Dutch entomologist and a group of American chemists.

The first step in the research program was obtaining a large enough sample of the pheromone to study and copy. Army scientists had tried and failed to do that at the government's Natick Laboratory back in 1948.

Entomologist C. J. Persoons, of Centraal Laboratorium in Delft, the Netherlands, succeeded in obtaining the pheromone by collecting 75,000 virgin female roaches, from which he got a grand total of 200 micrograms of the elusive periplanone B.

This small sample was sent to Dr. W. Clark Sill, chemistry professor at Columbia University in New York City. Dr. Sill and a team of scientists from Columbia and Cornell analyzed the sample and isolated and copied two chemical compounds.

They sent back the compounds to Persoons for testing. One of them turned out to be a foolproof copy of periplanone B. In fact, it was so potent, Persoons found that just 100 femtograms of the chemical—that's .00000000000001 gram—was enough to set his male roaches off on a mating dance. Scientists estimate that one hundredth of a gram of this substance is enough to attract 100 *billion* male roaches.

Once testing is completed, scientists hope to develop better bait for roach traps or even to disrupt the cockroach's reproductive cycle.

In the meantime, scientists are working on duplicating another female sex attractant, periplanone A, and a male one called—and this is its real name—seducin.

—DC

"The outcome of any serious research can only be to make two questions grow where only one grew before."
—Thorstein Veblen

GEODESIC DOMES

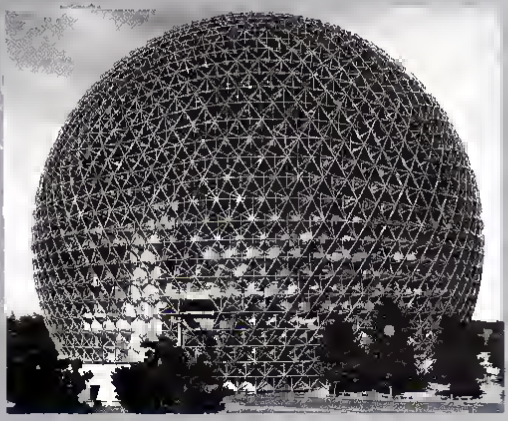
The geodesic dome for home or business, proposed by R. Buckminster Fuller in 1951, is finally gaining wide acceptance. Spurred by the dome's cheaper construction cost and energy use, thousands of people are building domed shelters covered with everything from aluminum to cedar shingles.

In San Juan, Puerto Rico, a metallic, silver-domed, 23-meter diameter discotheque opened this past April. A 32-meter domed theater is being finished at Caesars Palace in Las Vegas. Even a domed church is being built in Beaver Dam, Wisconsin. They are among 250 commercial domes by Space Structures, a Long Island firm. A California company, Monterey Domes, claims to have sold over 4,000 geodesic domes for private residences in 1978.

The domes are actually composed of numerous precisely engineered triangles fastened together with bolts and by similar simple means. This allows virtually all of the domes to be prefabricated and saves on construction costs. In some areas a complete dome house costs half as much as a conventional model.

Federal studies say the domes use up to a third less energy for heating and cooling than rectangular structures because each cubic foot of interior volume requires less surface area (for heat to leak in or out).

The National Association of Dome Home Manufacturers, in Chicago, has doubled its membership to 100 since 1976. Technological advances and high resale prices have curbed early problems such as leaks and difficulty in obtaining mortgages. —S.D.



Cheap to build and heat, geodesic domes are being used for homes, theaters, churches and even discotheques

CONTINUUM

RECYCLING BLOOD

The next transfusion you get may consist of your own blood At Walter Reed Army Hospital, in Washington, D C

Dr Eric Furman at work Patients with no blood cannot bleed

surgeons are giving patients back their own previously donated blood during operations Unlike blood from donors one's own blood doesn t contain unfriendly hepatitis viruses or antibodies that won t get along with the immunological system

Dr Arthur Fleming, chief of surgery at Walter Reed says his staff draws two to three units of blood (a unit is about 10 percent of total blood volume) out of a patient one unit at a time over a three-week period before surgery

The blood can keep for up to 35 days in a 4°C refrigerator or be put into deep freeze, where it can be stockpiled safely for as long as seven years

Dr Fleming claims that even though patients have been drained of a unit of blood a few days before their operations they go to surgery with their blood pressures and pulses pumping away per normal Even those with bad hearts and blood-pressure problems and patients undergoing open-heart surgery he says do well

In a related development some surgeons are draining up to 90 percent of their patients' blood during operations Soon after the anesthetic has taken effect doctors drain the bulk of a person s blood and replace it with a balanced salt solution

Then should the patient bleed during surgery, few blood cells are lost because he s bleeding mostly salt water The patient's whole blood is stored in the operating room, ready to be put back into his body

When the patient's blood is returned to him at the end of the operation, he is given a megadose of diuretics, which cause his kidneys to excrete the salt water

The main danger of blood draining is the possibility that the brain and heart won t get enough oxygen which is carried by red blood cells So doctors reduce the body s need for oxygen by cooling the patient down to 32°C giving blood-pressure-lowering drugs and using a very strong anesthetic

Dr Eric Furman, head of anesthesiology at Children's Orthopedic Hospital in Seattle, Washington claims that neither he nor anyone else using this technique has ever gotten a patient into trouble

"We have not yet reached the limits " he says, "of how much blood we can drain "—Mary Beazley

FIERY PROFILES

A beautifully dressed woman appears outside the house that she s set afire as if in a drama A man gets exquisite sensual satisfaction from torching a building A six-year-old child burns down his house because his parents withhold love

These are some of the profiles of arsonists detailed in the first comprehensive study of fire setters done for the National Bureau of Standards by two researchers at the University of North Carolina In *The Psychology of Firesetting A Review and Appraisal* Robert G Vreeland and Marcus B Waller say the common thread among adult fire setters is "social ineffectiveness, ' including sexual marital occupational and drinking problems Youthful arsonists, conversely, are most typically thieves and truants, the researchers said And only about 15 percent of arsonists are female

Aftermath of arson A thread of "social ineffectiveness "

The study was commissioned because of the marked increase in arson incidents and damage From 1964 to 1975 annual damage from known or suspected arson rose from $60 million to $633 million the number of fires increased from 30 900 to 144 000

The most rapidly increasing fire-setting group is the arson-for-profit group, the researchers said These arsonists range from the rich housewife who sets a smoky fire to collect money for redecorating to the welfare recipient who burns down his apartment to collect relocation expenses The report adds that certain entrepreneurs treat arson "as a normal business activity,' with a low risk of arrest and conviction

The suggested remedies vary from counseling to psychiatric help to incarceration depending on the arsonist s frame of mind Some pyromaniacs, the researchers found claimed they set fires to provide employment for firemen —S D

"As far as we know, our computer has never had an undetected error'

—Conrad H Weisert, Union Carbide Corporation

QUIET TOWN

It is only half as noisy in parts of Darlington, England as it was three years ago after a unique experiment

[illegible] ...ten years unless measures were taken to curb the increasing clamor Studies have shown that excessive noise in addition to causing hearing damage

Darlington England You can stand in the center of town and have a normal conversation instead of having to shout

with international implications was conducted

The town council decided in 1976 to find out just how quiet the community could become So it began a massive public-education program aimed at reducing noise from cars construction sites, factories clubs and other sources Local laws ordered mufflers on pneumatic drills and better shielding of machinery in factories Traffic was rerouted from the center of the town Schools, civic groups and businesses supported the project

The experiment known as Quiet Town was a national showcase, following a 1974 study that predicted England would be twice as leads to an increase in heart attacks strokes and other health problems and to a decrease in learning ability

In Darlington the difference is pronounced not only in the noise level but in the quality of life "You can stand on the sidewalk in the center of town and have a normal conversation with someone instead of having to shout or go into a shop said Keith Atkinson head of the Quiet Town experiment "You can tell just by the way people act that there have been psychological benefits" He said the town is more relaxing and many more people are now conscious of the damaging effects of noise, and so they curb their own noisy behavior

The Quiet Town experiment is expected to be used as the basis for a national program in England next year he said In the United States the federal government has instituted regulations to reduce noise from trucks lawn mowers airplanes and jackhammers but there has not been a massive public-education campaign to create an anti-noise ethic like the one that has developed in Darlington —S D

ANIMAL TRIVIA

The world s most finicky eaters are not the food critics of various newspapers and magazines They are instead caterpillars which would rather starve to death than eat a plant they find distasteful researchers have found

This tidbit and other amusing ones have been collected by the National Wildlife Federation Among them are

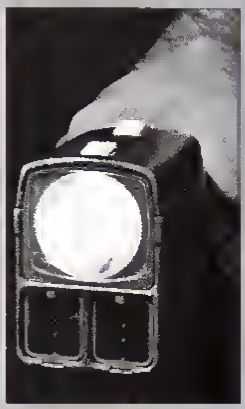
- Young giraffes can grow up to half an inch *per hour*
- The Venus s-flytrap, an insect-eating plant, takes between 10 and 35 days to digest one small bug
- Starting with one fertile female, Italian bees can produce 75,000 offspring in 13 weeks
- Killer whales will often use their enormous tail to flip their prey 30 feet into the air before eating it The prey includes seals, dolphins, and penguins
- You don t feel the pain and itching of a black fly s bite until after it's gone, because it applies a temporary anesthetic before biting
- Contrary to common belief, cats can see in color, but not always accurately For example they see an apple as red but a cherry as gray —S D

Caterpillars are finicky killer whales are flippant, flies are sneaky —but most amazing are the growing pains of a young giraffe

CONTINUUM

STUN GUN

It looks like a flashlight, bangs like a gun and stings like a bee—a very big bee Called the Taser, it is an elec-



Taser Electric darts are fired from boxes below the beam

tric stun gun used by police since 1975 and now available to civilians as well

The Taser was developed originally as a nonlethal alternative to the police officer s pistol Instead of wounding a victim, it merely stuns him It uses electricity not bullets

All a user has to do is aim the Taser and press a button A small gunpowder charge then propels one or two darts at the target Connected to these darts are thread-fine wires When a dart hits a small charge of electricity—three watts—jolts into the target This is enough to stun but not injure anyone, according to the Taser's manufacturer

The charge of electricity is strong enough to shoot through layers of heavy clothing but not so powerful that it would disrupt a pacemaker Each Taser is completely rechargeable and has the flashlight built in the front so that it can be aimed in the dark

Already used by 24 police departments around the country, the Taser was recently approved as a defensive weapon for civilians Even though it shoots electricity and is not lethal it is classified by federal law as a firearm and can be sold only by government-licensed gun dealers —D C

VIRUSES FROM OUTER SPACE

There may be no need to search for messages from space with radiotelescopes Two Japanese biologists think interstellar "telegrams" may already be here, waiting to be identified—in laboratories all over the world and in our own digestive tracts

The proposed messenger is a phage a virus that infects intestinal bacteria, called PhiX-174 When British scientists deciphered its complete gene structure two years ago they found that parts of its DNA code could be read three different ways depending on where the translation began

The Tokyo researchers Hiromitsu Yokoo of Kyorin University and Tairo Oshima, of the Mitsubishi-Kasei Institute of Life Sciences, think the code seems more artificial than natural An advanced civilization, they suspect may have applied to viruses a communications method already attempted by American radio-astronomers

The technique involves coding a message, either as radio pulses or as DNA bases whose total number is a multiple of *two* prime numbers The signals are laid out in rows like those in a television picture A message 899 (29 times 31) signals long for example would be arranged as 29 rows of 31 signals or as 31 rows of 29 signals to form a picture

There are three possible messages in the PhiX-174 genes One is 121 (11 times 11) units long, one is 91 (7 times 13) units long, and one is 533 (13 times 41) units long Yokoo and Oshima have already tested the first two "Unfortunately, nothing of significance has been found, ' they report. The scientists are currently working on the third possibility

A message-by-virus system would have several advantages over radio, the biologists point out There is no need for a receiver and an antenna aimed in the right direction at the right time There needn't even be anyone waiting to receive a message Landing in a suitable environment, the viruses would simply reproduce until intelligent life evolves to decipher them —O D

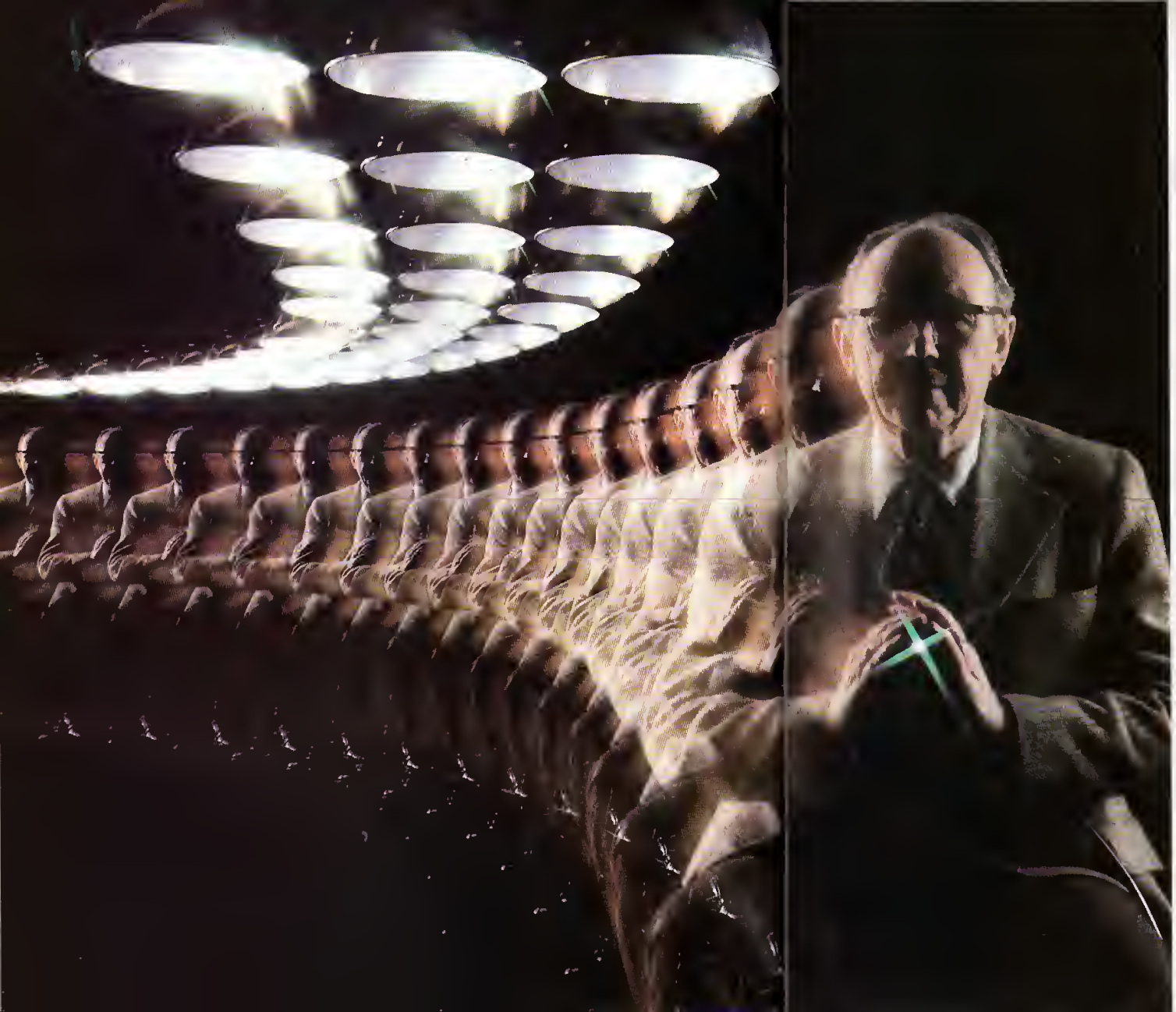
"A bit beyond perception's reach/I sometimes believe I see/that life is two locked boxes,/each containing the other's key'

—Piet Hein

DID YOU KNOW?

- Snowmobiles use over 117 million gallons of fuel each year in the United States
- Five percent of all the energy in the United States is used in supermarkets
- We use more than 80 gallons of gasoline to produce one acre of corn
- A 50-percent replacement of oil by nuclear power by the year 2000 would require ordering one large power station every 3 5 *days* (and no new power plants have been ordered in the past two years)
- About 1 5 quadrillion megawatt-hours of solar energy bombards the earth every year more than 28 000 times the amount of commercial energy used
- Up to 60 percent of the heat that commercial air conditioners must displace is generated by electric lighting —E R

Gas guzzlers Snowmobiles use more fuel than you might think



"DOC"

Welcome to the world of Harold "Doc" Edgerton— photographers' cult hero, grizzled explorer, distinguished professor, millionaire industrialist, inventor of everything from Brownie flashcubes to laser strobes

BY STEPHEN DAVIS

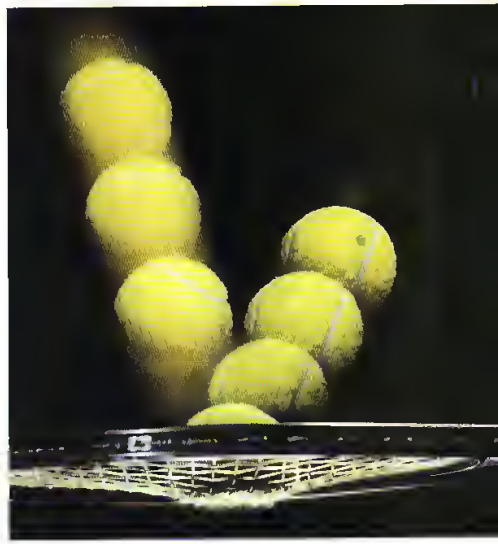
Hang around with photographers and you will inevitably hear Doc Edgerton stories. I've worked with some of the best—the hottest shots in the world—and eventually they all began to wax rhapsodic over this aging, bespectacled MIT professor and his incredible career. They speak of his Arthur Conan Doylesque exploits and cite his principal accomplishments: the first ultrahigh-speed photography, the first high-speed moving pictures, the first accurate night aerial reconnaissance during World War II, the first films of atomic explosions, the directing of Jacques Cousteau to underwater photography, the development of the side-scanning sonar, the first close-up pictures of the Loch Ness monster, and the list goes on and on.

Doc Edgerton is a man seventy-six years old and still going strong. Here's a typical Edgerton story, told to me by *National Geographic* photographer David Doubilet in a little bar not far from the society's Washington, D.C. headquarters. This story is typical in that it shows the awe with which many young men regard the stamina and skill of a man old enough to be their grandfather (which, in a figurative sense, Edgerton is).

"Back in 1974 Doc and some associates discovered the wreck of the *Monitor* [the Union Navy ironclad that sank in a storm after its epic battle with the Confederacy's ironclad *Merrimac* in 1862]. They had outfitted the Alcoa Sea Probe with Edgerton's side-scanning sonar and found the *Monitor*'s hulk lying upside down two hundred fifty feet under. So I'm assigned to work on the story, and we motor out to the site in a little boat.

"Edgerton wanted to test a new underwater 'deep-drop' TV system he had developed in order to retrieve a multiple-exposure camera that had snagged on the *Monitor*'s gun turret during a previous trip and had been

PHOTOGRAPHS BY BEN ROSE



lost. So there we are, twenty-eight miles off Cape Hatteras in the roughest water in the Atlantic. We can't operate when conditions are bad. So we're constantly motoring around, changing position, and we finally anchor up near the site for the night. We're in the middle of the shipping lanes. So it's important that everybody keeps watch.

Around midnight the sea begins to roll in huge swells, the wind is howling, the boat is rocking like crazy and the current is against us. I'm wedged in a lower bunk. Doc is in an upper bunk.

You sleep by wedging your neck against the bulkhead and your feet against the bottom of the bunk. It's not really sleep, it's isometrics.

"Suddenly the wind shifts, we're broadside against the swells, and everything is breaking loose. Total chaos. Doc, who then was seventy-one years old, is up like a shot, tying everything down. It's pitch-black, barrels and generators are thumping around, the sonar 'fish' is rolling around the deck completely loose. I hear Doc bumping around. I'm half-awake. I slowly open my eyes. He's pulling my foot and saying, 'Dave, Dave, wake up! I've got two things to tell you.'

"'What is it, Doc?'

"'First thing is, I hate boats. Terrible place to work, always moving. Terrible place.'

"'What's the second thing?'

"'Second thing is, *your watch!*'

Try to find Doc Edgerton's lab at MIT in Cambridge, Massachusetts, an institution generally unimpressed by its own scientific superstars, and you'll detect a certain reverential respect in the students' voices as they direct you to the fourth floor.

For 50 years Harold Eugene Edgerton has used the fourth floor as laboratory, classroom, consulting office, and base camp for hundreds of experiments and expeditions. Famous as the father of ultrahigh-speed strobe photography, Doc is still relatively un-

Ben Rose captures a circus couple on a unicycle, a speeding bullet in mid-flight, and a moving tennis ball with Harold Edgerton's stroboscope.

known outside scientific and photographic fraternities His strobe light, invented in 1930 gave the world a system of fast portable light that is vital for science, industry, and medicine, as well as for routine photography The strobe illuminates, beacons regulates, and heals It has even phototypeset the page that you're reading Doc also pioneered nighttime and underwater photography In fact, almost everything we take for granted about artificial light for photography from Brownie flashcubes to laser strobes that blink at 10^{-16} second, is an invention of Doc Edgerton's

Doc is a master of the optical unconscious illuminating minute shards of time we previously didn't know existed You've seen some of his masterpieces—they've been burned into the minds of millions in such magazines as *Life* and *National Geographic* the tiara-shaped milk droplet the bullet smashing through the apple the golfer's frozen swing the aerialist's stop-time multiple flip Stonehenge by night Slices of pure time frozen at instants as short as a millionth of a second

Edgerton's experiments in the related fields of stroboscopy ultrahigh-speed photography and sonar have led to an exhaustive career that has leaped from one adventure to another He's taken pictures of everything from hydrogen-bomb fireballs to bats on the wing from grim rockscapes of the ocean's floor to the delicate rhythms of hummingbirds in flight For years he worked with French aquanaut Jacques Yves Cousteau building cameras and their underwater housings designing bathyscaphes exploring for sunken treasure ships rare fish and vanished civilizations After he "lost interest" in photography in the Sixties Edgerton turned to sonar, taking pictures electronically with sound instead of with light

Despite his protean reputation as inventor and adventurer for generations of MIT students Edgerton has left his mark as a teacher not your standard theory-obsessed science professor slapping differential equations on the blackboard but a hands-on practical experimentalist (his word) with a real power to inspire his students Doc retired from his electrical engineering professorship in 1966 This meant that he relinquished his day-to-day teaching load but he was immediately given the title of Institute Professor an extraordinary distinction and one rarely bestowed by MIT Perhaps the one immeasurable quantity in Edgerton's life is the respect and love given to him by the highly competitive MIT community

We tried to maintain Edgerton's brisk pace one day recently as he crossed MIT's central quadrangle dominated by its massive black Alexander Calder stabile An impressive number of colleagues and students yelled out "Hey Doc" and some came over to shake his hand or touch him lightly on the back as if he were a touchstone of both technological brilliance and old-fashioned midwestern openness

"Doc is very much a *pure* scientist" one of his students told us later that day "That means he's more interested in solutions to a problem than in the theories behind the problem itself" Edgerton's life in fact has been dedicated to creating technology for practical problem solving a consequence of which likens his career to an extended Conan Doyle tale More than one of his MIT associates compares him to Doyle's flamboyant Professor Challenger—a sort of scientific Sherlock Holmes

MAKER OF SMOKE AND FIRE

Doc was born in Nebraska in 1903 He recollects "My father got me a summer job at Nebraska Power and Light when I was a University of Nebraska undergraduate I'm still very grateful because I was thrown into the hassles of running an early electric-light plant with all the pressures and confusion I learned a tremendous amount That's why they [MIT] hired me here I knew how to run the machinery see things happen make the smoke and fire come out"

It was Edgerton's curiosity about the plant's huge generators with their rotating and vibrating components that initiated his interest in the stroboscope The basic stroboscope had already been in existence for at least 100 years however before Edgerton started to tinker with them they were little more than scientific toys used for games and optical illusions (The illusion performed by the primitive stroboscope is based on a phenomenon of human vision The retina of the eye retains the image of an object in one position for about a tenth of a second after the object moves to another position)

Early stroboscopes were rotating wheels observed through a hole in a spinning disk The wheel appeared stationary when seen through a disk that permitted a view of the wheel only once per revolution with the wheel in the same position each time Edgerton reasoned that he could achieve the same effect by flashing a light at the wheel at regular intervals if the light were bright enough and precisely synchronized with the movement of the wheel

Under conditions as they existed in 1925 at Nebraska P&L and later at the General Electric works in Schenectady New York where Edgerton took a job after graduation technicians were unable to discern the motions of speeding parts in their generators When the inevitable problems occurred the cause could only be guessed at Edgerton figured that with some kind of stroboscopic-light effect the pistons and flywheels could be examined while in full motion

Doc went to Cambridge in 1926 to study motors While working on his doctorate the following year he tried to find an industrial application for his stroboscopes When he worked at GE he had found a weak flashing lamp that one of the engineers had built in an oak box "It was very crude Doc

"May I suggest that in today's group-therapy session we all work on our contact with reality"

remembers. "They had taken a neon-sign transformer that gives a little peak and put a small capacitor across the lamp and stuck it on the secondary so every half-cycle would give little oscillations. It was just another way of getting stroboscopic effects. The theory had been worked out a hundred years before. What got me was that many of these transients happen in a tenth of a second or less. You can't see them; you have to use photography to get it on paper so you can take it apart at your leisure and plot it up.

"The equipment we had for that in those days was zero. So I got a mercury tube that was made for a rectifier, not for a stroboscope at all. But mercury vapor gives off a nice blue high-energy light. If you put it in a big enough condenser and get the circuits right, you can get flashes in less than ten microseconds. We found we could do photography right off! Movies, sequence pictures, almost anything at all."

I asked what problem was the first to be resolved using ultrahigh-speed strobe light.

"We were working at the time [1929–30] on what happens when you put a sudden load on a motor. It swings in time with the phase angle, and we measured the phase angle correctly. I wrote up a mathematical treatment using the first computer here at MIT—the *first* one. I still can hardly believe it—but this was our first practical problem, a nonlinear second-degree equation with cosine function in it. You can't solve it with formal mathematics, but you can with a computer, although we called the machine a differential analyzer in those days. So I had all these solutions for the technical paper we'd written, but I knew that when I presented it to the big electrical engineering convention, it would be almost incomprehensible.

"The solution was to make a movie with this new lamp that showed the electrical motor and the pole oscillating and showed the sudden load put on, and it turned out to be very graphic. Then people around here started coming in for help with other problems. I remember I went over to Professor Draper's lab and they said, 'Edgerton, why don't you take pictures of other things?' I was naïve in those days, and I said, 'What else is there?' Draper said he had valve springs that did all kinds of crazy things. So I loaded the whole system in my station wagon, set it up, and ran it. But it ran too hot. So we just punched some holes in the side of the box. We looked at these valve springs with the strobe, and they were fantastic. Then Draper wanted to know what happened to the fuel spray inside the diesel engine. So we built a lamp right inside the cylinder, and they squirted the juice in there, and we got real nice pictures of this spray at one five-thousandth of a second. And that was the beginning."

To provide the requisite energy for the brilliant flash they needed for the strobe, Doc and his associates (Kenneth Germeshausen and Herbert Grier, with whom Edgerton has had a lifetime partnership) developed reservoirlike condensers, in which energy could be slowly accumulated and from which it would then be released very quickly. They found that if they placed a xenon gas tube between the condensers, they could control the intervals at which the electricity flowed from the condensers across the open gap of the tube, thus Edgerton and his partners could regulate the flash duration (as short as a millionth of a second) and intensity which proved capable of a brightness greater than that of the sun.

Edgerton published the first description of his strobe in the May 1931 issue of *Electrical Engineering*, causing something of a sensation. The *National Geographic* used the technique to get pictures of hummingbird wings beating 55 times a second. Engineers began to adapt the strobe to examine their machinery in motion. Still in his twenties, Edgerton was hailed as one of the century's technogeniuses—a designation he views with amused reservation.

> *"His strobe light, invented in 1930, gave the world a system of fast, portable light that is totally vital for science, industry, and medicine, as well as for routine photography."*

"You must realize that what I did wasn't all that new," he maintains. "The first spark photo was made by Fox Talbot with a windburst machine in 1851, and before that there were lightning strokes. All you had to do was open your camera and let nature give it a whack. So people ask me whether I invented the strobe, and I say, 'No, it came from heaven.' The only improvements we made were to make it go off when and where we wanted it to. The thing that really tickles me is that you could hardly pick up the first strobe. Now they make them so small that you can get a half-dozen in your pocket."

Throughout the Thirties Edgerton continued to develop and promote the strobe light. He held dozens of demonstrations for scientists, businessmen, and the press. One of these yielded the famous 1938 photo of the tiara-shaped milk drop that can be seen in New York's Museum of Modern Art. *Life* photographer Gjon Mili, using an Edgerton-built studio, began publishing spectacular stop-motion pictures of dancers, ice skaters, and circus performers. By the end of the decade the strobe had become a basic tool in both science and industry. Edgerton also published his first article about high-speed movies in 1934. By replacing the movie camera's mechanical shutter with a strobe timed to flash for each frame of film, Edgerton came up with a uniform, continuous film speed that raised the number of frames per second from 250 to 6,000. Eventually the Hollywood movie studios lured Edgerton to California to adapt some of his techniques for special-effects purposes. Alas, it was fate, in the guise of World War II, that kept him away from Lotusland.

SECRETS OF 'STROBE ALLEY'

The material that Edgerton published during the war years reflected his fascination with unlocking natural secrets through his strobe light, it also masked the top-secret war work that he and his team were performing up in Strobe Alley, Doc's fourth-floor chambers at MIT. Behind "An Analysis of the Locomotion of the Seahorse by Means of High-Speed Cinematography" Edgerton was inventing aerial strobe-reconnaissance techniques that became one of the deciding factors in the defeat of Nazi Germany.

"I was working in the lab one Saturday in 1938," Doc recalls, "and a stranger walked in and said he was Major Goddard from the Army Air Corps. They had been using flash-powder bombs left over from World War I to get aerial pictures at night, and he wanted to know whether we could adapt our strobe lamps to take night pictures from two thousand feet high. I said, 'Sure we can build one, but you don't have an airplane big enough to take it up.' He said that times were changing and that they were working on a new plane, something like a DC-3, that could carry four to five tons. So we figured the specifications on the slide rule, extrapolated them into an unknown region forty or fifty times bigger, and sent it over to the Air Corps.

"A few days later I received a two-hundred-page contract in the mail from the War Department [now Department of the Army] to build this thing. I got myself a red pencil and crossed out the whole contract except for about four lines at the end, which stated the objective of the job. I wrote back that we accepted the contract except for the parts blocked out in red. A little later I got a call from some lieutenant saying you can't mess around with a War Department contract like that. I told him, 'I don't waste my time with lieutenants, get me a general!' I didn't have any more trouble with them after that."

Edgerton was sent to Italy in 1943, where he supervised the Air Corps's use of the aerial strobe in more than 80 missions, as the German troops were being pushed north. In England in June 1944, with his equipment mounted in six A-20 night fighters, on the night before D-Day Edgerton produced clear pictures of a cloud-covered Normandy by piercing the murk with incredibly quick bursts of intense light. The

strobe had gone to war. And the strobe contributed to the Allied victory.

To some extent the postwar generation was raised on Edgerton's next project, the utterly chilling films of A-bomb and hydrogen-bomb tests. In 1946 Doc was approached by the Atomic Energy Commission (AEC) to design a testing camera for atomic explosions, whose blinding light rendered conventional photographic apparatus useless. (The light from the first atomic blasts was so hot that it actually burned tiny holes into the exposed film.) Edgerton came up with a strobe-activated shutter that allowed exposures for as short as one microsecond. In 1947 the AEC suggested to Edgerton and his partners (Grier, who was working on A-bomb circuitry, and Germeshausen, involved in radar) that they form a company to consult on and manufacture devices for atomic testing. The AEC gave the firm of EG&G (Edgerton, Grier, and Germeshausen) an exclusive franchise on postwar nuclear testing; the company has supplied the detonators and trigger systems and has measured the AEC's tests ever since.

Edgerton headed the corporation from its founding to his retirement in 1966. Sitting in his laboratory earlier this year, in response to my request, he darkened the room and projected a series of H-bomb films he had made during the Eniwetok Atoll tests of the early Fifties. Somehow the repetitive black-and-white films of apocalyptic fireballs, shock waves rushing over the darkened ocean, and mushroom clouds produced an almost restful narcotic effect on me. I asked Doc whether he had felt any queasiness about the nuclear program in those days, so soon after the horrors of Hiroshima and Nagasaki exposed the world to the endgame of nuclear weaponry. He turned off the projector and sank back into his chair. "Well, I've always said it's a lousy way to fight a war. Everybody loses. You poison the earth and get nothing but overkill. But you also have to remember the feeling at the time. The Russians had stolen our big secret. They got it through spies and were going ahead, building the weapons and banging these things off. It took us ten years to do it, and it took them only six months. But I didn't even have that much to do with the actual testing. The government started us in business, and I took a term off here and there to work on it, but mostly they'd just come to me when they had a problem. Frankly, at that time I was much more interested in getting clear shots of hummingbirds."

NEW FOCUS ON THE DEEP

But Edgerton the Cold Warrior soon found another diversion and application for his strobe light. "The National Geographic Society called me one time, about 1953, and said they had a young man in their office who was interested in underwater photography and they wanted him to come up and see me. So he rode up to Boston on the train, and we got acquainted. He was an eager-looking guy with a big schnozzle. He said his name was Cousteau. He had worked on the aqualung, and I had just gotten one. So as soon as he arrived, I had him on the bottom of the MIT pool as the test pilot for my new underwater camera. He stayed with my wife and me that night, and we just made a lot of plans."

During the next five years Edgerton and the Frenchman worked on the techniques and equipment that would open up the mysteries of the undersea world. Doc designed an undersea flash system capable of operating in the deepest parts of the oceans; concurrently he also had to design underwater housings that could withstand subsea pressures of up to 8.5 tons per square inch. Edgerton's adventures with Cousteau also led to the invention of ultrasonar photography. In 1957 Cousteau achieved a mid-Atlantic anchorage using a nylon rope at eight kilometers' depth.

Trying to get pictures of the ocean bottom, Edgerton positioned his camera with a "pinger," a device based on stroboscopic principles but using sound instead of light. The sound waves from the pinger returned as echoes from the seabed, indicating the camera position relative to the bottom. Edgerton noticed that the sonic pulses not only reached but penetrated the muddy layer on top of the ocean floor. He began

CONTINUED ON PAGE 104

FICTION

The astronaut trainees had to be taken down a peg— or so their officers thought

KINSMAN

BY BEN BOVA

Chet Kinsman is a young Air Force lieutenant, training to be an astronaut. His first mission in orbit, aboard a space shuttle, teams him with Lieutenant Frank Colt, black, brilliant, quick-tempered. Since Kinsman and Colt have scored highest among the astronaut trainees so far, the older officers in charge of the shuttle have decided to take them down a peg. Colt sees this as discrimination against him. And Kinsman realizes that his own chances to be an Air Force astronaut are inextricably linked with Colt's.

From the forthcoming novel Kinsman, *published by Dial Press*

When he finally slid out of his bunk, Kinsman felt too keyed up to be tired. Colt seemed tensed like a coiled spring, too, as they pulled on their pressure suits.

"So the Golddust Twins finally get their chance to go EVA," Smitty kidded them as he helped Kinsman with the zippers and seals of his suit. "I thought they were gonna keep us after school," Colt said, "for being naughty yesterday."

Pierce'll find a way to take you guys down a notch," Jill said. "He's got that kind of mind."

"Democracy in action," Kinsman said. "Reduce everybody to the same low level."

"Hey!" Art Douglas snapped, from across the compartment where he was helping Colt into his suit. "Your scores weren't that much higher than ours, you know."

"Tell you what," Colt said. "A couple of you guys black your

PAINTING BY JOHN SCHOENHERR

faces and see how you get treated."

They laughed, but there was a nervous undertone to it.

Kinsman raised his helmet over his head and slid it down into place. "Still tits okay," he said through the open visor. "Guess my head hasn't swollen too much."

Captain Howard slid down the ladder railing, already suited up, but with his helmet visor open. The pouches under his eyes looked darker than usual, his face had a gray prison pallor.

"You both checked out?"

Mr Personality, thought Kinsman.

Howard wasn't satisfied with the trainees' check of their suits. He went over them personally. Finally, with a sour nod, he waved Colt to the airlock. The lock cycled, and then Howard himself went through, closing the metal hatch behind him.

Kinsman slid his visor down and sealed it, turned to wave a halfhearted "so long" to the others, then clumped into the airlock. The heavy hatch swung shut, and he could hear faintly the clatter of the pump sucking the air out of the phone booth–sized chamber. The red light went on, signaling vacuum. He opened the other hatch and stepped out into the payload bay.

Colt and Howard seemed to be deep in conversation, back beside the only remaining satellite in the bay. Kinsman shuffled toward them, keeping the lightly magnetized soles of his boots in contact with the steel strips set into the deck plates.

Colt tapped Howard on the shoulder and pointed to Kinsman. *Like scuba divers in an underwater movie.* Kinsman said to himself. Howard turned, tapped the keyboard on his left wrist, and held up four fingers.

Kinsman touched the button marked *Four* on his own wrist keyboard.

Howard's voice immediately came through his earphones. "We're using channel four for suit-to-suit chatter. Ship's frequency is three; don't use it unless you have to talk to the flight deck."

"Yes, sir," said Kinsman.

"Okay. Let's get to work."

Under Howard's direction, Colt and Kinsman peeled away the protective aluminized sheeting from the third and final satellite in the bay. It was a large, fat drum, tall as a man and so wide that Kinsman knew he and Colt could not girdle it with their outstretched arms. The outer surface of the satellite was covered with dead black solar cells.

"Kinsman, you come up top here with me to unfold the antennas," Howard ordered. "Colt, get back to the main bulkhead and open the doors."

Floating up to the top of the satellite with the captain beside him, Kinsman asked, "What kind of a satellite is this? Communications?"

"In a polar orbit?"

"Oh. No. I guess not. We've changed orbital planes so often that I didn't realize."

"Start with that one." Howard pointed to the largest antenna in the center of the drumhead.

Kinsman hung head-down over the satellite and read the assembly instruction printed on it by the light of his helmet lamp. The antenna support arms swung up easily and locked into place. Then he opened the parasol-folded parabolic dish that was the antenna itself.

"Now the waveguide," Howard commanded laconically.

"It's not an observation satellite," Kinsman said as he worked. "No ports for cameras or sensors."

"Keep your mind on your work."

"But what the hell's it for?" Kinsman blurted.

With an exasperated sigh, Howard said, "Strategic Command didn't bother to tell me, kid. So I don't know. Except that it's top secret and none of our damned business."

"Ohh . . . a ferret."

"A what?"

"Scuttlebutt that we heard back at the academy," Kinsman explained. "Satellites that gather electronic intelligence from other satellites. This bird's going into a high orbit, right?"

Howard hesitated before answering. "Yes," he replied.

Nodding inside his helmet, Kinsman went on. "She'll hang up there and listen on a wide band of frequencies, mostly the freaks the Soviets use. Maybe some Chinese and European bands, too. She just sits in orbit and passively collects all their chatter, recording it. Then when she passes over a command station in the States, they send up an order and she spits out everything she's recorded over the course of a day or a week. All data-compressed so they can get the whole wad of poop in a few seconds."

"Really." Howard's voice was as flat and cold as an ice tray.

"Yes, sir. The Russians have knocked a few of ours down, or so they told us at the academy."

Howard's response was unintelligible.

"Sir?" Kinsman asked.

"I *said*," he snapped, "that I never went to the academy. I came up the hard way. So I don't have as much inside information as you bright boys."

Touchy!

"Colt, when the hell are you going to get them doors open?"

"I'm ready anytime, sir," Colt's voice came through the earphones. "Been waiting for your order."

"Well, open 'em up, damn it, and get back here."

Soundlessly the big clamshell doors began to swing open. Kinsman started to return his attention to the satellite, but as the doors swung farther and farther back, he saw more and more stars staring at him, hard, unwinking points of light, not like jewels set in black velvet, as he had expected, not like anything he had ever seen before in his life.

"Glory to God in the highest," Kinsman

"and a side order of fries."

heard himself whisper the words as he rose, work forgotten, drifting up toward the infinitely beautiful stars.

'Get your ass back here, Kinsman!' Howard shouted. It was like ice picks jabbing at his eardrums.

"But I never thought..." Kinsman found himself drifting halfway down the payload bay, high enough so that his head and shoulders were out in the open. He grabbed a hinge of the open door to steady himself.

Colt was beside him. "Fantastic!"

Kinsman realized his mouth was hanging open. But he didn't care. Inside the helmet, in the utter privacy of his impervious personal suit, he stared at the universe, seeing it for the first time. It was endless, shining, hypnotically beautiful.

"All right, all right." Howard's voice was softer, gentler. "Sometimes I forget how it hits some people the first time. You've got five minutes to see the show. Then we've got to get back to work or we'll miss the orbit-injection time. Here—" and Kinsman felt a hand on his shoulder—"don't go drifting loose. Use these for tethers."

He felt a line being hooked into one of the loops at the waist of his suit. Looking around, he saw Howard do the same thing for Colt.

"Go out and take a good look," Howard said. "Five minutes. Then we've got to count down the satellite."

Kinsman floated free, outside the confines of the ship, and let the full light of Earth shine on his face. It was dazzling, overpowering, an all-engulfing expanse of curving blue decked with brilliant white clouds. Hardly any land to be seen, just unbelievably blue seas and the pure white of the clouds.

It was *huge*, filling the sky, spreading as far as he could see, serene blue and sparkling white, warm, alive, glowing, a beckoning, beautiful world, the ancient mother of mankind. The earth looked untroubled from this distance. No divisions marred her face, not the slightest trace of the frantic works of her children soiled the eternal beauty of the planet. It took a wrenching effort of will for Kinsman to turn his face away from her.

By turning his body, Kinsman could see the sun shining so fiercely that even his heavily tinted photochromic visor wasn't enough protection. He squeezed his tearing eyes shut and spun away, angry yellow splotches flecking his vision.

"Can't see the moon," he heard Colt say.

"Must be on the other side of the earth," he answered.

"Look! That red star. I think it's Mars."

"No," Kinsman said. "It's Antares... in Scorpius."

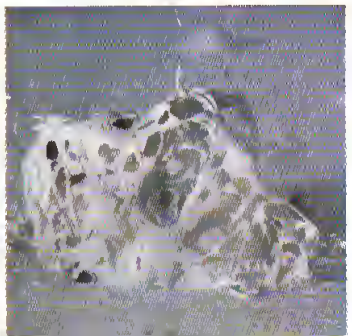
"Christ, it's beautiful."

When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained...

"All right, all right," Howard's voice broke through to them. "Time to get back to work. You'll get plenty of chances to see more."

CONTINUED ON PAGE 107

Bubbling paint pots (right) are caused by steam rising through groundwater, Mammoth Springs (above)



GEOSCAPES

BY ERIC ROSEN

Sculpted by heat and cold, these awesome terrains may yield universal secrets

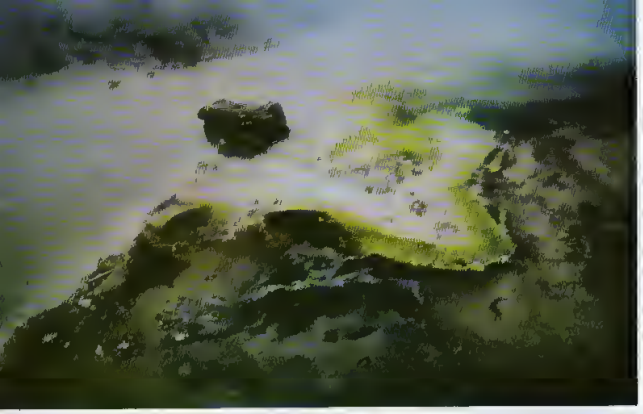
PHOTOGRAPHS BY DOUGLAS FAULKNER

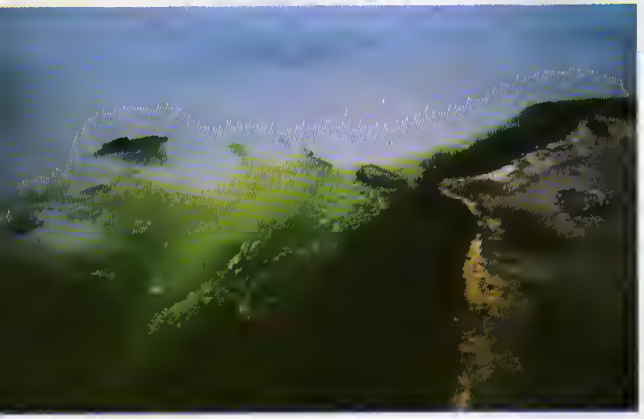
A vast frozen wasteland lies in the glare of a far-off sun. Everything is silent. In the deep cold, no organism moves. Gases billow forth from fissures in the ground, blanketing the surrounding area with a dense mist. Enormous palaces of crystal and ice slowly grow in endless layers of colors and shapes.

This could be a description of our outermost planet, Pluto, or of some light-years-distant world. It is, in fact, the wintry landscape of Yellowstone National Park, our first and perhaps grandest natural preserve. Created in 1872 by an act of Congress, Yellowstone is the interface between the heat of the earth's core and the cold of the atmosphere—a place where an explorer can find spouting geysers, steaming fumaroles, and molten mud pots.

The otherworldly appearance of Yellowstone is heightened dramatically in the winter, especially with the absence of visitors from the park, in striking contrast to the traffic jams of summer. Douglas Faulkner, best known for his underwater photography (*Omni*, May 1979), made a cold-season pilgrimage to capture the splendor that is Yellowstone.

The geology of Yellowstone gives scientists clues to the inner workings of our planet and, by inference, to the secrets of other worlds. Jupiter's satellite Io, for instance, appears to have an active volcanic surface. The





Clockwise from left: Snow-line meets the heat of Upper Geyser Basin, the Emerald Pool's striking colors result from reflected sunlight and yellow algae, runoff near Sapphire Spring yields a rainbow of algal colors, thin layers of a silica rock known as sinter form Castle Geyser, an irregularly shaped vent of a thermal geyser

geysers of Yellowstone are indicative of the volcanic activity that formed the Rocky Mountains. Similarly, the crystalline structures that make up the various hot springs of Yellowstone can help us understand what happens to chemical compounds under extreme conditions. Space, probably the harshest environment of all, furnishes a unique set of circumstances to those who want to explore it. Yet space, too, is ruled by the same physical and chemical laws that govern the geology of Yellowstone. By first understanding Yellowstone, we may be able to ease our transition to other, possibly habitable, worlds.

Biologists also go to Yellowstone to study and discover. There, algae and bacteria live in close symbiotic relationships—on the surfaces of rocks as well as in the depths of pools. The various colors seen in these photographs are actually of different species of algae, each color corresponds to a temperature and acidity gradation within the pool.

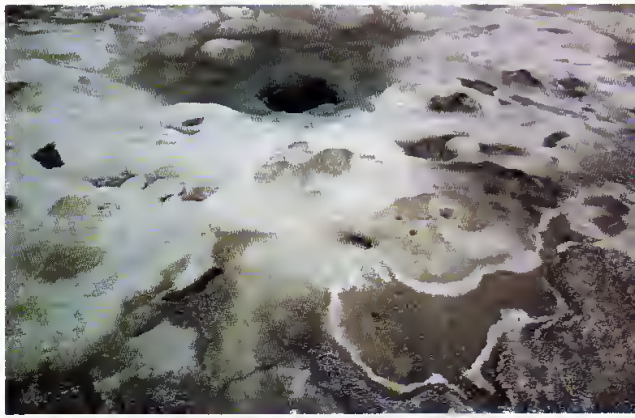
Deciphering Yellowstone's secrets may shed light on other worlds.

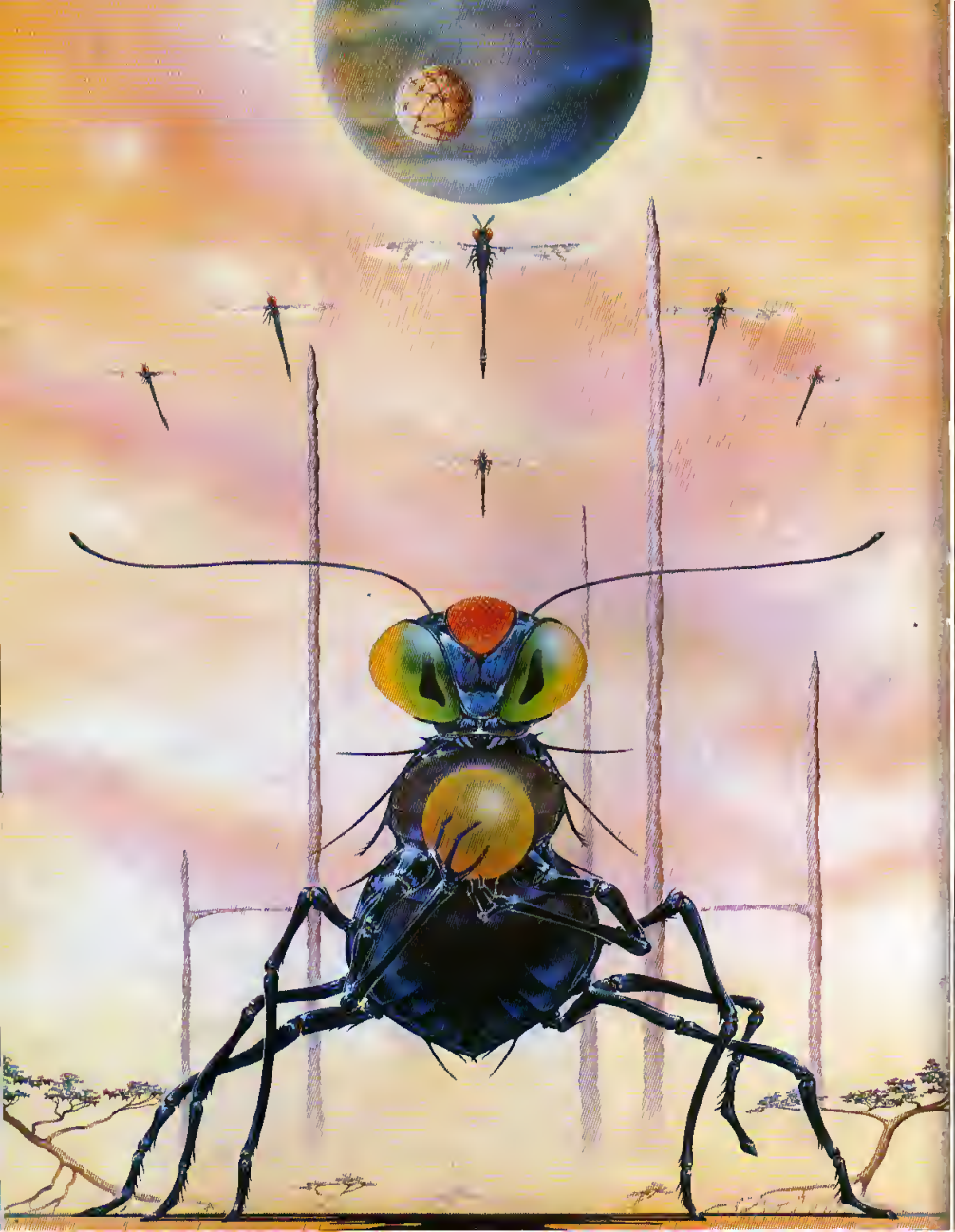
The studies of contrast and changes in both plant and animal life in Yellowstone may be of great importance in the future. For example, "perfect" environments may not be needed to support the huge algal protein factories we may eventually build in space; perhaps algae can be adapted to a wide range of acidic environments much like those in the pools of Yellowstone. It is possible that a close examination of the thermal gradients in the pools and surrounding areas will yield solutions to our energy situation; machines may be designed to take advantage of gradients like these to produce electricity. Thus today's studies of these earthly environments may provide tomorrow's answers.

Yellowstone is a land of extreme contrasts—a land where the torrid heart of the earth is mingled with the cold of the air. The awe and wonder that a visitor experiences there may be surpassed only by the unimaginable beauty of a planet's frozen landscape in deepest space. ∞

"Enormous palaces of crystal and ice grow in myriad colors and shapes."

Above: The terraces of Mammoth Springs are actually layers of travertine, a calcium carbonate rock carried in solution and deposited by water. Top: Symbiotic algae and bacteria inhabit the surfaces of the rock terraces. Middle: Snow crusts over the edges of a hot pool. Bottom: Snow-covered terraces at Mammoth Springs.





The random chemistry of evolution has spread inhuman minds throughout the galaxy

LIFE IN DARWIN'S UNIVERSE

BY GENE BYLINSKY

Tantalizing perturbations in the motion of distant stars suggest that planetary systems are common. When the veil is finally lifted from these faraway planets, what will we find? To start with, there are two kinds of life we probably won't find: exact replicas of man and those darlings of early science fiction, silicon-eating monsters with ammonia flowing through their veins.

The famed Harvard paleontologist George Gaylord Simpson wrote in his book *This View of Life*, in 1963, that "there is increasing recognition of a new science of extraterrestrial life, sometimes called exobiology—a curious development in view of the fact that this 'science' has yet to demonstrate that its subject matter exists!" Simpson, now retired in Tucson, Arizona, is still waiting for exobiology to show that its subject matter exists.

The surprising thing today is that Dr. Simpson, and the rest of us, may not have long to wait. An urgent new drive to locate planets circling distant suns is getting under way. The great space telescope that NASA plans to put into orbit in 1983 will have a mirror 241 centimeters across, almost half the size of the largest Earth-based telescopes. It will see objects one-fiftieth as bright as the faintest bodies visible through the 508-centimeter telescope atop Mount Palomar, in California. For the first time astronomers should be able to photograph planets of other stars.

Even before we see these planets, however, we can rule out any hope of finding silicon-based life on them. That notion fails to stand up under the now-certain knowledge that the same chemical elements exist everywhere in the universe and that the physical laws that apply here also govern planets millions of light-years away. The recent discovery by radioastronomers that the universe is teeming with carbon-based molecules, which are the building blocks of life, strongly suggests that carbon is life's central element everywhere.

Silicon-based life simply doesn't work. Silicon molecules don't have the properties of organic, carbon-based molecules. They don't react readily, they don't combine, and they don't have double or triple bonds—all the things that allow biochemistry to take place.

"It looks as if God is an organic chemist," says Dr. Cyril Ponnamperuma, a prominent student of life's chemical evolution, at the University of Maryland. "Anywhere you direct your radiotelescopes, what do you see? You see these two molecules, hydrogen cyanide and formaldehyde. These two can provide the pathway for everything else. And they are the very things we get in laboratory mixtures that imitate the primitive conditions under

Given stronger exoskeletons and a more efficient air supply, there is no reason why insect organisms could not grow large enough to carry a man-sized brain

PAINTINGS BY WAYNE McLOUGHLIN

"Intelligent beings may look humanoid, but the differences will be fundamental and profound."

which life as we know it arose on Earth billions of years ago."

In recent years radioastronomers have identified 50 chemicals in interstellar space. Of those, no fewer than 45 have biological significance—all carbon compounds. "There is a simplicity in the whole scheme," Dr. Ponnamperuma comments, "so much so that you almost feel the whole universe is trying to make life. With the knowledge of organic chemistry from the work we've done, I'm willing to say that eventually we'll define life as a property of the carbon atom. The first thing I tell my students is that a professor in the constellation Andromeda is teaching the same course I am."

If carbon substitutes don't work, neither do substitutes for water. Not only is there a lot more water than ammonia in the universe, but the temperature range in which water remains liquid is much wider than that of ammonia. To take place, biochemical reactions require a liquid solvent, such as water.

And while intelligent extraterrestrials may look somewhat human, the differences will be fundamental and obvious. There is nothing in nature that dictates the emergence of brainy apes. Instead, evolution has acted like a living, supersensitive tree, sending out intricate, ever-changing branches into the environment. There is nothing preordained about the success of these branches. In fact, most evolutionary experiments wither and die in short order.

Dr. Simpson, our Harvard paleontologist, likens evolution to a lottery in which most of the ticket holders are losers—they become extinct—while some receive small prizes and a few become big winners. "Man simply happens to be the descendant of a long line of organisms that drew winning tickets in every successive adaptive radiation," he writes. "The basic adaptations of his ancestors have proved, in hindsight, not to have closed out the evolutionary future." Can a similar lottery take place on other planets?

The forms of animals everywhere are governed by the same physical laws. They will dictate some major similarities between life on other planets and that on Earth. For mammals, as well as for amphibians and some reptiles, one head, two eyes, and four limbs are ideal. In the sea, such creatures as the octopus and the starfish took on a radial form that enables them to see in all directions at once. Yet on land even an octopus would find walking on all fours more convenient than lumbering along on more legs. The pitter-patter of more than four feet may work for insects and arachnids, but larger organisms would stumble all over themselves. Some of the early fish that came onto the land may have had six fins, but their descendants have four. Nature favors simplicity and centralization as key survival patterns.

Similarly, to swim rapidly, a creature has to assume a fishlike shape. To fly, it needs a streamlined, somewhat fishlike shape with wings. There is no getting around these physical constraints, and there is no reason to believe that such limitations will not exist on other worlds. They may be somewhat different, to be sure—trees on a larger planet, for instance, would be short and squat—but they will be there.

Physical requirements will dictate even seemingly minor details. A striking example on Earth is the development of camera eyes in mammals and in cephalopods such as the octopus and squid. Although different in details, the eyes in both cephalopods and mammals exploit the same principles. They are called camera eyes because, like a camera, the lens focuses an image of the object being viewed onto a plane of light receptors which take the place of film. Nature discovered those principles long before man did and applied them to two radically different kinds of organism because it's the only way to construct a nearly perfect eye. Again, because all worlds are governed by the same physical laws, parallel developments elsewhere seem inevitable.

In short, biologists see life forms on other planets following evolutionary paths that coincide to some extent with ours. Yet they will differ significantly; exact duplicates of earthly evolution are highly unlikely. Although other life-bearing planets are expected to resemble Earth closely, even to have blue skies, they won't be perfect replicas. Some may be smaller, some larger. Some may be completely covered with water.

On planets without dry land, the ocean would still teem with life forms strangely similar to our mollusks. Whalelike and dolphinlike creatures would be absent; for those are mammals that went back

Giraffelike beings (above) might inhabit a low-gravity, forested planet; the Batman's hands would limit technological skill despite his potent mind.

to the sea. Biologists call such creatures reentrants. An ocean planet would also have primitive fishlike creatures, crustaceans, starfish, urchins and similar spiny-skinned creatures.

On the landmasses of other planets too we can expect to find organisms that seem faintly familiar. The history of life on Earth clearly shows that animals of different ancestries will seize any evolutionary opportunity and will solve whatever problems face them in essentially the same way. On Earth three different vertebrates have developed wings: the reptilian pterodactyls, birds, which grew from a different flightless reptile, and the mammalian bats. Insects were geared for flight too, of course, but they approached it somewhat differently. Instead of restructuring a quadruped frame for flight, insects somehow grew wings as original equipment.

Millions of years have separated basically unrelated creatures that ventured into similar "occupations" and wound up looking very similar. Two such creatures are the extinct ichthyosaur and the dolphin. Dolphins evolved tens of millions of years after the ichthyosaurs were gone. Like all life on Earth, these two animals once had common stock—but ancestors very much unlike either of them and dating back more than 200 million years. The dolphin, of course, is a mammal that went back to the sea, while the ichthyosaur was a reptile that also made the transition.

This fascinating evolutionary phenomenon is known as convergence, though the term is usually reserved for developments that occur at about the same time. For example, on three different continents, more or less simultaneously, there evolved wolflike carnivores: the "true" wolf of Eurasia and North America and the marsupial, or pouched, "wolves" of South America and Australia. There is good reason for such convergence. All these carnivores evolved to chase other creatures, and the wolflike shape fits that role best.

In another striking example, the hummingbird and the humming moth have only the remotest common ancestry. Yet they have converged so remarkably in physical appearance, in flying habits and in feeding on the nectar of flowers that at dusk and at a distance it is difficult for us to tell one from the other.

Convergence doesn't always lead to similar forms, however. The kangaroo is the Australian counterpart of the cow and other hoofed grass-grazers—a hint of how creatures on other worlds may differ from our fellow Earth dwellers.

Finally, a single creature, given enough time and a big enough stage on which to act, can give rise to a veritable zoo. The wildlife of Australia radiated from a primitive pouched opossum that somehow managed to island-hop from Asia perhaps 70 million years ago. From that single ancestor developed the kangaroo, the koala, the flying-squirrellike phalanger, a native mouse, a cat, a mole, a sloth, the groundhoglike wombat and even an anteater. Although all these animals except the kangaroo and the koala resemble their placental counterparts on other continents, they are only distantly related to them.

Elsewhere, the placental mammals—the "true" mammals—radiated to fill the ecological niches available to them. In Australia the pouched marsupials did it because there were no mammals of significance to compete with them. Australia "had only some rats and bats as early representatives of the mammalian legions.

A fascinating lesson can be learned from these earthly examples of what to expect on other worlds. There is no reason to believe, for instance, that life elsewhere, given the opportunity, will not try to fill ecological niches similar to those on Earth.

Dr. Simpson and other biologists have argued persuasively that evolution is nonrepeatable and irreversible. If evolution were starting over again on a primitive Earth, neither man nor other animals would again evolve into their present form. Too many unpredictable happenings contributed to man and the other mammals now living. If, as one scientist has commented, a planet must be exactly the right distance from just the right type of star if it is to bear life, then man just barely squeezed through a crack in the evolutionary door. Some Devonian fish fortuitously developed lungs—not to become landlubbers but to cope with their own oceanic problems. Climatic changes, solar and cosmic radiation and many other factors all influenced the mutations that led to higher animals. There were altogether too many random events in this history for it to be duplicated exactly on another planet.

> *"Life such as ours, with water and carbon, is just an ephemeral stage. Most life is either disembodied mind only or the silicon form we call the computer, an immortal species."*

Yet physical niches mold the animals that will inhabit them. The air calls for flying creatures, the land for vertebrates that walk on all fours or on two hind feet, the sea for swimmers. Animals evolving at different times in distant places will vary in the size of their brains and in skeletal details, just as the three different "wolves" and the ichthyosaur and dolphin did. But their general shape and function could come surprisingly close to those of earthly beasts.

Even the skeptical Dr. Simpson concedes a long-shot possibility that manlike creatures might emerge on other planets. We would have to assume that they evolved from ancestors somewhat similar to those of man and that they passed through the arboreal environment that gave man his stereoscopic vision, skillful hands, and the beginnings of a large brain.

Humanoids, most scientists agree, are likely to compose only a tiny minority of the intelligent life in the universe. Most other intelligent beings will almost surely have started from very different stock and will therefore not resemble man.

We already know, however, that animals need not climb trees to develop impressive intelligence. The noted biologist Norman J. Berrill observes: "The fact that the porpoise, without having enjoyed living in the treetops, without having become a hunter on the plains, has somehow managed to produce a brain whose complexity is comparable to that of man is a puzzlement. It does show that we must not base everything on human experience. And, therefore, large, intelligent brains are possible without having gone through our story."

There might be another, more complex, route to highly intelligent land dwellers—a return from the sea. Such an evolutionary reversal would require unimaginable millennia. It would take perhaps 100 million years to reshape the seal into the doglike landlubber it appears once to have been. Unfortunately, the dolphin seems to have gone too far to reshape the vestiges of its hind flippers into legs again. It appears that the dolphin must have been an intelligent four-legged animal before it returned to the sea that nurtured its ancestors.

And yet it seems most likely that land animals elsewhere develop their brains as man did, in the trees. Because their environment is similar to ours, these otherworldly beings will have features we'll recognize—heads, eyes, ears, noses and so on. Yet few of the intelligent creatures elsewhere will be attractive by our standards. "You wouldn't necessarily go up and embrace one," Dr. Berrill says.

What kind of intelligent being evolves depends, of course, on the ancestor that ascended into the trees. Many species other than man are possible. If a marsupial "ape" descended from the trees to walk upright, the being that evolved would resemble man, but the females would come equipped with pouches to carry their prematurely born babies.

Such equipment would neatly solve a problem that may block the further evolution of man's brain. At birth, our brains are already so large that they barely fit through the pelvic opening. If the brain is to grow further, future humankind must either enlarge the birth canal or manipulate the developmental processes so that the brain can continue to grow long after birth. Our marsupial cousins, though, could grow much bigger heads and perhaps be much smarter than we are. They might be as far

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FICTION

GRAVESIDE WATCH

The time capsule would be buried there—but who would dig it up again? And when?

BY EDWARD H. GANDY

They just finished digging the grave today. We could bring our sleeping bags and lie beneath the stars all night," said Frank, pressing the phone receiver to his ear and waiting for her answer. He peeked inside the coin-return mouse hole of the public phone. There were no forgotten dimes, but someone had left in it a dead fly, to discourage refunds to the more timid. "Hell, every teacher gets bummed out at the end of spring term. That's why you're so depressed, Elaine. It happens to me, too. But a good view of the Milky Way puts the whole college year in perspective. What do you say? I hear it's very proletarian."

Using his shoulder to pin the receiver to his ear, Frank finished reading the graffiti on the side of the phone booth. Graffiti were important elements in anthropology. A bulletin board for the anonymous. A scratch pad for the long minutes on hold. Raw thoughts. Raw art. Raw life. He checked on the fly again. Still dead. He started to lean against the glass wall of the phone booth, but he slumped down, dejected.

"What? What do you mean? It's not like we're spending the night in a cemetery. It's the only grave there is on Raven Hill. And besides, it's not really a grave, just a huge hole."

It was hot in that little glass house on the sidewalk. After a couple of minutes he was perspiring and speculating about photosyn-

PAINTING BY GAGE TAYLOR

thesis. *Damn.* Two days in this phone booth would have saved Elaine's African violets. They died today. She was telling him about it for the fourth time. He opened the door, stepping back to try to catch some of the early evening breeze, but the phone cord wasn't long enough. They never were.

"I'll buy a loaf of bread and some wine," he cut in. "What do you say?" After a polite pause, Elaine took up the slack in the conversation with some straight talk about sunlight and humidity. Not to mention bugs—which she did.

Frank extended his arm, braced his hand on the phone, and did some more leaning. What else was there to do in a phone booth? He began thinking about tomorrow's burial. After all, he had a right to be proud of his efforts. He was only a teaching assistant, and yet he was the one who put in for the grant, landed it, formed a committee, and launched the whole time-capsule project. He even wrote up the press releases. Not to mention licking the postage stamps—which he did. Hundreds of them.

And there were other drawbacks. Like camping out on the top of Raven Hill tonight, to keep an eye on the hole. Not that anyone was going to steal it—the college president had assured him with a smile—but liability-insurance rates dictated the presence of a hole watcher. Trying to make the best of a bad situation, Frank had thought two hole watchers would better demonstrate a genuine hand-in-hand effort toward casualty prevention. More specifically, it was a good excuse to spend the night under the stars with Elaine.

He could just see her white skin glowing in the moonlight, her softness contrasting with the ruggedness of the outdoors. He could see them slipping into the lush forest, rolling naked in the grass, bits of straw and pebbles clinging briefly to her dreamlike flesh, which fluttered at the slightest touch.

Unfortunately, the idea of exposing oneself to the universe next to an open grave did not sizzle when it hit the fire of other people's imagination.

"Ah, c'mon, Elaine."

Reality was no match against Frank's remarkable imagination. Never was and never would be. Even the psychiatrists had been unable to help. Frank had stopped seeing them long ago, but he was still paying the bills.

"Yeah, I understand. Maybe some other time. Right. Talk to you later." He slammed the receiver down on its cradle. *Great,* he thought, as he jumped into his car with his camping gear. *Cut to the quick by a dead plant.* The world was definitely after him.

Frank raced through town as if the world was gaining on him, although he knew he shouldn't be treating his Pontiac like this. He downshifted to take the steep incline of the hill.

He finally stopped his car when the pavement ended. The last quarter mile to the top was bare dirt. He decided against allowing his car to get down on the flesh of the earth. Spinning wheels, groaning engine, soft shoulders, loose gravel, rocking back and forth in a hole that gets deeper—it was all too Freudian. He would walk.

Frank shook his head to nudge his thoughts in another direction. *Too much idle speculation,* he reminded himself as he shouldered his backpack. Always speculating on this or that. Problem was, "this or that" could run from the rational to the ridiculous in a flash.

He took a deep breath of pine-scented air to clear his head and then walked up the road to the grave.

Although the hill was thick with trees, there was a grassy clearing at the very top. Frank was almost there when, suddenly, he smelled smoke. He looked up and noticed a light. It was the glow of a flickering campfire. He moved to the side of the road and walked toward the edge of the clearing. As he got closer, he heard the crackling of the fire. Peering through a bush, he saw an old man in a tight vest and baggy pants bending over to pour himself a cup of coffee. Frank could see the open grave a couple of feet from the fire and a large mound of dirt next to the hole. The old man sat down and spoke without bothering to look up.

"Not five minutes ago I saw a snake glide into that bush you're hiding behind, son."

Frank gingerly stepped into the open and then became embarrassed at being flushed out of the brush like a common quail.

"Excuse me," said Frank, trying to appear casual. "But what are you doing, here?"

The old man looked away. Frank's eyes followed his until they came upon a wagon, a medicine show wagon. A lantern, attracting the attention of a number of flying insects, hung from a rusty hook at a corner of the old wagon. Frank could barely make out the dimly lighted sign painted on one side of the rig. The red lettering formed two half circles, one inside the other. G. O. SAGEHORN AND HIS TRAVELIN' MEDICINE SHOW.

"Want some coffee, son?"

"Wha—?"

"Coffee." He whistled sharply, and Frank stepped back at the sound of movement under the wagon. A German shepherd came trotting out. Frank thought the dog was beautiful, even though it was quite dusty. The old man banged the side of the coffeepot with a stick, and the dog jumped into the back of the wagon. Moments later it came out with a tin cup in its mouth and ran up to him.

"Sit down, son." He took the cup and filled it. "What's your name?"

"Frank," he said, hesitating. "Frank Henderson."

"Well, I hope you like your coffee black."

"Ah, yeah," Frank said, sitting down rather slowly and eyeing the man.

"Good. Sagehorn's the name, and this is Plato." The dog raised its head at the sound of its name. Frank nodded to both of them as Sagehorn handed him his coffee.

Sagehorn was an odd-looking man. His

'He said, 'Thy faith hath made thee whole' and told me to come back in two weeks for a checkup.'

long hair and bushy eyebrows were white, his eyes watered, his nose twitched, and his face was pushed forward slightly as if he were squinting into a strong wind. Indeed, Frank would bet that the old man could stand in front of a closed window and make it appear to be windy.

"Quite a hole," said Sagehorn, gazing at the grave.

"Yeah." Frank turned to look back at the wagon again, not sure of what to think. He noticed a horse by the trees. He could feel his boyish imagination rioting inside him, trying to get out but not succeeding. Frank was too edgy in these strange surroundings to be anything less than alert. A thought occurred to him.

"Did you come to see the burial?" he asked.

"Most assuredly. As soon as I heard about this time capsule, I packed in my show, put my horse and wagon in a truck, and headed for Oregon."

Frank gave Sagehorn a cold look. "Burial's not until tomorrow. Are you camping here tonight?"

Sagehorn surveyed Frank's sleeping bag and backpack. "I might ask you the same question." He seemed offended.

"Lighthouse keeper," Frank explained. "It seems that I've been elected to come up here and throw a light on the hole. Make sure some poor astronomy student doesn't drop out of sight in mid-stride."

"Yes, that *would* be a nasty fall."

Frank nodded. "Yeah, it's a deep one, all right. But the time capsule will be there for a long time."

Sagehorn smiled. "Yes, indeed. I'm sure it will. And, as a matter of fact, I have a plan that will determine whether the capsule will be found and opened a thousand years from now."

"Well, we've taken a few steps to make sure it will be found."

"Such as?"

"Nabbed a government grant. Need I say more?" But Frank did, for he never passed up a chance to talk about his capsule. "The capsule wasn't built in metal shop," he concluded after running through a list of problems the subcontractors had had in building something that could survive for a thousand years.

Sagehorn seemed to be really interested. Intensely, almost like a child would have been. "What other steps have you taken to ensure its discovery?" Sagehorn asked.

Frank looked up in time to see a shooting star over the trees. He remembered searching the sky for them for hours when he was a boy. But shooting stars aren't really stars at all. He knew that now. Sometimes it was better to have a child's faith. At least it didn't get bruised as badly. He looked at Sagehorn and studied his wind-blown face for any hint of a second childhood. The old man certainly had one foot in the past, with that wagon. Question was, Where was his other foot?

"Well," said Frank, "we've printed up

hundreds of small books. They describe the time capsule's location and ask that it not be opened until the year 2980. In fact,' and his tongue grew dry at the memory, "I spent most of last week mailing them out to museums and the rare-book sections of libraries all over the world. Even a few monasteries." He shrugged. "The time capsule will probably survive and be remembered.'

"Well, if it *is* found and opened a thousand years from now I'll know about it within two weeks."

Frank concealed a smile behind his cup. "Oh? How?"

"I'll show you." Sagehorn got up and walked over to his wagon. Brushing by the lantern and the insects, he climbed into the front of the rig and disappeared over the seat.

With cup in hand, Frank wandered over to examine the old sign more closely but became distracted by the lantern. It resembled the nucleus of an atom. Bugs became electrons in their various orbits. He turned and took a deep breath to clear his head and cool his imagination.

But it didn't work. Through a break in the trees he could see the lights of the city in the distance. He searched through the pattern of quiet lights until he recognized those of the university. There was the glitter of Washington Boulevard, the street he and Elaine walked down on the way to the campus—talking about their students, sharing the morning air. And over there—three streets down, just this side of the neon lights of Manchester Boulevard—that was her street. *And over there, that dark area must be the park. No, the golf course, maybe. No, not big enough.*

Sagehorn swung back over the seat and dropped to the ground. The wagon squeaked and nodded its relief. "Just put this inside your time capsule." He held out a small metal box.

"Capsule's already full. Invention of yours?"

"Hardly. To talk to someone from our future does *not* require some sort of invention." He raised, or rather hoisted, his heavy eyebrows. "Simple logic will suffice."

Frank looked down and aimlessly swirled the coffee around in his cup. "Logic? To talk to someone from our future?"

"It's based upon a simple theory of time travel. Lecture circuit, you know." He tugged at his vest. "Speak at colleges, county fairs, outdoor festivals, and such, using the frontier medicine show as my format. Adds a bit of flavor to my lectures. Although, I confess, it's my card tricks that bring the people to my wagon."

"Well," said Frank, looking back over his shoulder, "I think the wagon itself would suffice, I mean, draw the crowds."

Sagehorn didn't see the humor. So Frank cleared his throat to suppress the tickle in his thoughts. They both walked back to the grave and sat down. The fire was warm, and Frank was glad to be next to it again. He heard the wind start to blow—first in the trees to the left, and then in the trees over the wagon. He wished he was here with Elaine instead of this crazy old con man? Maybe Sagehorn was obviously trying to arouse his curiosity. But why? Frank finally relented a bit. "What's your theory about time travel?'

Sagehorn poked at the fire with a stick and smiled. "Simply put, that there are time travelers among us right now."

Frank began swirling his coffee again, and the fire crackled in agreement.

"Really," Sagehorn said, "it's a most logical theory if you assume that man will *eventually* accomplish anything he puts his mind to. In a thousand years he will most assuredly discover the secret of time travel. He will journey into his past to discover how the Pyramids were built, to attend the trial of Socrates, to witness the crucifixion of Christ. So it must be logical to assume that there are time travelers among us right now. Only problem is, flushing one out into the open. And I have a plan that will do just that."

> *Frank could see the open grave a couple of feet from the fire and a large mound of dirt on the other side of the hole. The old man sat down . . . without bothering to look up.*

"I see. What's your plan got to do with my time capsule?"

"Your time capsule, if it survives a thousand years, will be opened by a society that has the ability to travel back through time."

Frank rolled his eyes up in disbelief. "Impossible?" said Sagehorn.

"What time travel? The whole concept contains too many contradictions.'

Sagehorn looked down at his metal box and rubbed the edge of it with his index finger as if there was a smudge on it. "*Contradiction* is a most tricky word, son. After all, what's in a contradiction?"

Sagehorn let the question dangle in the wind for a moment while he pulled a cigar out of his vest. He bit off one end and employed the grave as a spittoon. "Point of view."

"Oh?"

"For example, twenty-five hundred years ago Pythagoras claimed the earth revolved around the sun. Well, anyone could see it was the sun rising and setting. So obviously, from their point of view, it was the sun doing the revolving." He pulled his stick out of the coals and lit his cigar with it. "Ah,' he continued between puffs, "but that apparent contradiction didn't disturb Pythagoras in the least, not in the least."

"Truly admirable of him, but we've progressed a little since then."

"*Exactly!* In the past thirty years we've advanced more in science than in all of history. For the first time we're experiencing a geometric progression of knowledge. Our scientific information is doubling *every five years*. My God, if that acceleration rate remains the same, then we're talking about doubling something two hundred different times before that capsule will be opened. Why, take a single penny, double it twenty-seven times, and you're a millionaire! Twenty-seven times! With that kind of acceleration of learning, can you imagine what will happen after doubling our knowledge two hundred times? Can you really say that time travel will remain an impossibility forever? Well?"

"Okay," said Frank, too tired to face off and go toe to toe with him on a verbal mat. He was beginning to realize that he was outclassed anyway. Sagehorn might be crazy, but he was also well prepared to defend his theory.

"So, what's in the box?" Frank asked.

Sagehorn grinned, picked up the box, and brushed some imaginary dust off the lid with the back of his hand. "A scroll that tells a most interesting story. Used a special paper and ink to ensure that it survives the thousand years. Yes, I've baited this hook very carefully."

"What are you using for bait?

"Well, what better way to lure a time traveler out into the open than with another time traveler? Specifically, a supposedly stranded time traveler in need of rescue. I mean, if they do any kind of exploring in this time dimension, they're bound to lose a few poor souls. People who never come back from their journey through the past. People lost in a strange dimension, stranded in some ancient era. An Amelia Earhart–type of disappearance in the oceans of time. I think it's safe to assume such an occurrence.'

"Murphy's Law."

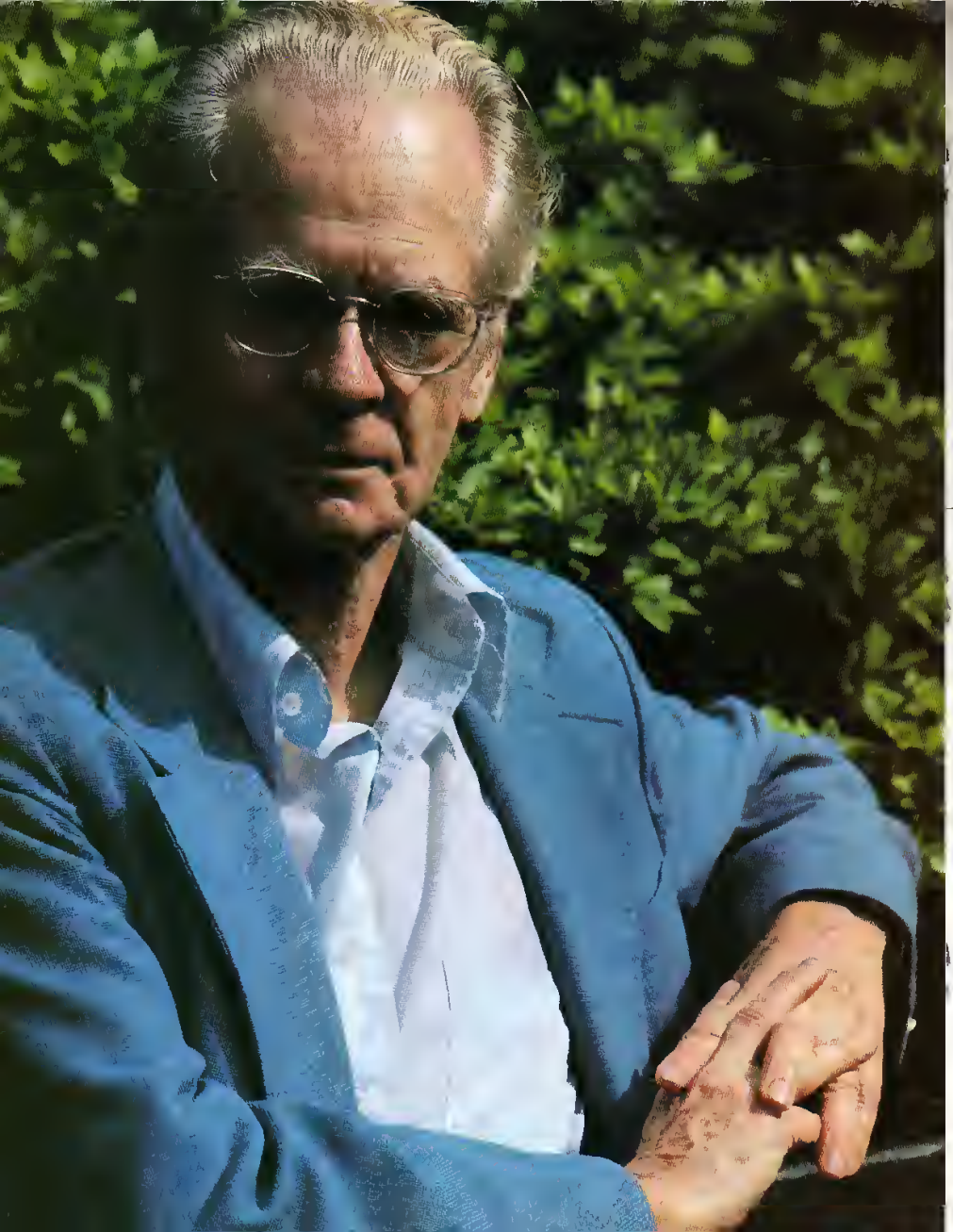
"Precisely. And suppose you were a time traveler grounded in the twentieth century. How else to get a message to the future, telling of your plight, than through a time capsule?'

How else, indeed? It struck Frank as an interesting notion. He couldn't help thinking about it for a moment. "One question," he said. "As I understand it, your scroll portrays a time traveler stuck in this century. Now it seems to me that our language is bound to go through some drastic changes in the next few centuries. Wouldn't a real time traveler jot down his S.O.S. in some language of the future?"

"Ah, but the scroll is never purported to be written by the time traveler himself. It's written by a friend who knows of his true origin, who helps him survive in this primi-

CONTINUED ON PAGE 114

Hi, honey—I'm home."



America's most influential psychologist wonders whether we take the future seriously enough to survive. What counts, says B. F. Skinner, is not our beliefs or our ideals but our behavior.

INTERVIEW

B.F. SKINNER

Photograph by Pat Hill

In one of his essays, Professor B. F. Skinner reprints a cartoon that shows one mouse exclaiming to another: "Boy have I got that guy up there fixed! Every time I press this bar he gives me food!" Who is controlled, and how? Is the experimenter, in his desire to verify a theory or to win the acclaim of colleagues, really any more "free" or autonomous than the mouse? Questions like these—questions that concern the causes, conditions, and control of behavior—have been Burrhus Frederic Skinner's absorbing study for 50 years. And his answers have directly challenged our most cherished belief—that we are essentially self-directing beings tenaciously grasping the reins of our own destinies.

After a Pennsylvania boyhood marked by a wide-ranging "curiosity" (he rejects the label; see p. 79), Skinner began his career as a graduate instructor at Harvard in 1931. At that time the school of psychology known as behaviorism had been developing for two decades along lines laid down by its founder, John B. Watson. It is only stimuli and the resultant behavior, Watson had insisted, that the psychologist can observe and measure; therefore, only stimuli and behavior (rather than motives, drives, emotions, or other abstractions) could be the foundations of a genuinely scientific psychology. The goal of such a discipline would be the prediction and control of behavior. No one since Watson has done more to develop techniques for achieving those intriguing if controversial goals than B. F. Skinner has.

He has been a researcher (the "Skinner box" for operant conditioning of animals, the first teaching machines, the "air crib" for efficient and healthy infant care); writer (*The Behavior of Organisms*, *Walden Two*, *Beyond Freedom and Dignity*); and teacher (at Harvard, the University of Minnesota, Indiana University, and finally Harvard again, where he has been Pierce Professor of Psychology since 1958). While his experimental techniques and findings are widely accepted, his interpretation of them—and his advocacy of their application to social goals—has kept him at the center of controversy. Skinner, however, remains unflappable.

Critics have charged that his approach denies all that is most important about human beings and that its influence could lead to a society of puppets continually manipulated by rewards and punishments, or "positive and negative reinforcements." But we are *already* manipulated, Skinner rejoins, by parents, institutions, and such economic forces as advertising. "The best defense I can see is to make all behavioral processes as familiar as possible. Let everyone know what is possible, what can be used against him. When people are being pushed around, controlled by methods that are obvious to them, and when things become too aversive, they turn against the controller."

That Skinner wants to see behavioral principles used to fulfill human potential has not spared him vehement opposition. "What people *do* about such a scientific picture of man," he says, "is call it wrong, demeaning, and dangerous, argue against it, and attack those who propose to defend it. They do so not out of wounded vanity but because the scientific formulation has destroyed accustomed reinforcers — such as the reassuring but unprovable notion of free will. An accomplished and deliberately provocative controversialist, Skinner feigns surprise at the sometimes violent reaction to the utopian community depicted in *Walden Two*. "I've often asked myself, What's eating these people? Apparently the main difficulty is that my 'good life' was planned by someone."

The ideas of planning and control are so loaded that it is sometimes difficult to remember Skinner's first and lasting commitment to attain a scientific understanding of human behavior in accord with the evidence, rather than with what we *might like* to believe. Largely owing to Skinner's influence, that understanding is growing steadily. Its promise for the future was explored between Professor Skinner and *Omni* interviewer Michael Hollingshead.

Omni: Can there ever be a genuine science of human behavior?

Skinner: It all depends on how complete a science you mean. There are things the biochemists can't explain, and the astronomers know how difficult it is to make sense of the radiation coming in from the universe. Their fields are obviously much more advanced. But there is at least a "core science" of behavior.

I don't think for a moment that we'll ever be able to predict what an individual will do next, because that depends on his genetic makeup and personal history and we can never know enough about that for detailed prediction. But we *can* discover general processes at work in every individual, and with those we can conduct experiments to improve our knowledge and develop a technology of behavior — better ways of teaching, of inducing people to work carefully and well and to enjoy what they're doing, of solving psychological problems, and so on.

Omni: Perhaps the best-known tools of the behavioral technology you've envisioned are negative and positive reinforcement — punishment and reward. There seems to be a long-term tendency in your work to move toward the latter.

Skinner: Yes. I don't like punishment. I don't like to be punished or to see others punished. One of the first tasks of a science of behavior should be to find substitutes for traditional punitive methods. Over the centuries we've successfully moved away from many of them, as in education and psychotherapy. Now it is being done in industry, too. Many people feel that a worker's wages are positive reinforcement, but they aren't, really. You don't work on Monday morning for the paycheck on Friday afternoon; you work to avoid being discharged and missing the paycheck. In other words, an industrial-wage system establishes a level of existence from which you can be cut off if you don't work.

Systems that involve positive reinforcement yield better results and remove the side effects of negative reinforcement that people try to escape — absenteeism, frequent job changes, and so forth.

Omni: You've spoken of the possibility of a controlled environment for retarded people. Can you expand on that?

Skinner: I think the goal there is to build a "prosthetic" environment. Eyeglasses, hearing aids, crutches are prosthetic devices that enable people to function well despite deficiencies. Why can't a whole institution be a prosthetic environment, a world in which a retarded person can lead a reasonably dignified, happy life? It won't be the everyday world. Unfortunately, it also won't be the world of most institutions for retarded persons, because they are political footballs and don't have the money they need to work along these lines.

Omni: In *Walden Two* you envisioned a "controlled" environment that would stimulate growth and happiness. Today there are several communities based on those ideas. Did you imagine that this would happen?

Skinner: I was guessing at what might be done. I wrote the book in 1945, before there was any behavior modification based on operant principles. There had been some work on the desensitization of fears, but the background of work we have now just didn't exist.

I guessed wrong some of the time, but right I think, a surprisingly large part of the time. I described a world of minimal consumption and minimal pollution and of maximal socializing and opportunity for creative behavior. It substitutes direct interaction for economic exchanges and police action. Instead of punishing your neighbor by going to the police, you censure with a frown. There are no contrived reinforcers. No one passes out tokens or candies. It's a world so designed that the behaviors needed to keep it going are automatically reinforced.

Omni: A recent documentary film showed your visit to Twin Oaks, one of the communities based on *Walden Two*. The question of "detection" was raised, where people come for a short time but don't stay on. In fact, only one of the founding members was still there after twelve years. Did they ask for advice on how to create a more stable community?

Skinner: I don't believe they were asking me for advice, but I thought they paid attention when I made some suggestions — for example, about their scarcity of entertainment. There was almost no money in their budget to make life interesting. They had a fiddler for square dancing but very little equipment for recorded music. There was no television set, but they are now putting in a single color set with a video recorder so that a program can be put on a cassette and people can drop in at any time and play it. I suggested also that by adding a video camera they could record their own plays and other programs.

I don't think their high turnover is as much of an implicit criticism as you might suppose. People go to Twin Oaks, spend a year or two, and leave, but they leave in much better shape than when they arrived. It's a therapeutic experience for many people who learn how to get along well enough to adjust to the outside world, which is where they may eventually prefer to be.

Omni: The idea of an extensively *planned* community worries many people, perhaps because they associate planning with despotism and associate "muddling through" with democracy.

Skinner: There's nothing necessarily autocratic about planning. I don't see it as a problem, if I'm to judge from the communities that are modeled a bit on the pattern of *Walden Two* — not completely, of course, they're too small, for one thing, nor are the residents all good behaviorists. I understand that at East Wind, a similar community in Missouri, they tried for a few months, as an experiment, to get a consensus on every decision. If it works better, then you adopt that way, that's how things should be done. Twin Oaks has had groups who practiced meditation. At one point there was a strong anti-*Walden Two* group, and it was tolerated. No one suppressed it.

Omni: But the question of control keeps arising, because the planned environment seems to presuppose a controller.

Skinner: *Quis custodiet ipsos custodes*? I don't see why my answer to that isn't more easily understood. The control you see, emerges in the evolution of cultural practices. I'm not talking about social Darwinism, the emergence of a culture that will "take over," but about successful practices within a culture. If you design a better way of teaching, who is to put it into effect? Those, obviously, who profit from good teaching. At present the educational establishment in America is so inert that no one is in control of anything except a tradition that

squanders half the lives of millions of people.

The thing about a small community is that everyone is asking, "Will it work? Will it survive?" We don't ask those questions about, say, the American way of life, because we think it's going to survive long enough that we needn't worry. In a small community when it appears that a practice increases the chance of survival, that practice is adopted. You don't need a controller. The demonstrated advance takes control through action that furthers the adoption of the practice.

If the survival of America were really threatened by a twenty-percent illiteracy rate, or whatever it is today, then new ways of teaching reading and writing would be adopted quickly. But we're not worried enough. If you have a culture that takes the future into account, then steps are taken *before* you reach the stage where some totalitarian 'controller' steps in and talks about destruction to make survival important to people.

Omni: The word *survive* has been very important in the recent transformation of China. The Chinese people were told the nation wouldn't survive if they didn't work toward certain social goals.

Skinner. Any revolution brings that into play almost immediately. The Soviet Union has never gotten over its fear of attack since 1917. The whole question is, What kind of conformity contributes to the survival of a culture, and what kind threatens it? After all, we want conformity in paying our taxes, obeying the law, respecting the rights and property of others, and so on.

Omni: What about education? People resist the idea of teaching machines, which they think of as leading to too much conformity in the students.

Skinner: I object to teaching everyone precisely the same thing, because diversity is essential. A system that doesn't recognize this threatens survival.

Omni: You have said that we should teach things more important than geography, arithmetic, and such like—things such as ways of memorizing, clear thinking, three-dimensional thinking.

Skinner. I don't think anyone has adequately analyzed the behavior we call thinking; certainly no one I know of is working on the most effective ways of teaching it. Trying to teach people to think would be a good way to discover what thinking really is.

Omni: Are you describing the teaching of abilities rather than teaching facts?

Skinner. I don't believe in "abilities." To say that an artist is creative because he possesses creativity is double-talk. If you look at what the creative artist *does* that is different from what others do, you might find out something that would suggest ways of producing more creative behavior.

Or take "curiosity." People don't look about them because they possess a trait or faculty of 'curiosity.' They look about because looking about has been reinforced, because surprising things have turned up

underneath objects and around corners If you grow up in a world in which everything is visible you go through life accepting whatever you see and never exploring

Omni: How do you distinguish between operant conditioning and what Konrad Lorenz calls imprints—genetic neurologically determined behavior that seems to be released accidentally and is very powerful? Doesn't conditioned behavior require continual reinforcement?

Skinner: You don't ask why one goes on eating sweet things all one's life! The sweet things are there to reinforce the behavior of eating It has been clearly shown by Neil Peterson, one of my students that what is inherited in the case of imprinting is *not* a tendency to follow the mother or another imprinted figure. as Lorenz's gosling followed him it is a *susceptibility to reinforcement by proximity* Peterson showed that if, when a duckling pecks at a spot on the wall you bring the imprinted object closer the duckling will continue to peck In nature the behavior that brings an object closer is walking toward it But Peterson went on to show that if you arrange things so that the object moves away when the duckling walks toward it and comes around in front when the duckling walks away, the duckling will walk away So even that "innate" behavior depends on appropriate reinforcement

There may well be redundant mechanisms though A colt struggles to its feet after being born and stays close to its mother probably as a result of natural selection although I daresay we could also get it to stamp its hoof to make its mother come close as Peterson did with the duckling in another experiment

Omni: Do you apply your findings to motivate yourself?

Skinner: Yes quite definitely Most of my professional life these days is verbal—I no longer have a laboratory—and I have carefully designed a world in which I can come up with as much verbal behavior that is strictly mine as possible I could write books by commenting on or revising what others have said and written I could get books out of books, but I don't I get them out of my own research my own books and my own life

Omni: Can you extrapolate to others? Are there general principles by which we can learn to guide ourselves?

Skinner: Oh yes Several books have recently been published in the field of self-management You don't control yourself by using your willpower but by arranging a world in which behavior that is important to you actually occurs You control your behavior precisely as you would that of someone else I'm not saying that I do this perfectly or that anyone can But by noting the conditions under which we work well and by making every effort to maintain them, we can maximize the probability of the behavior that is important to us

Omni: Is writing conditioned by the reward of seeing it in print or would you say it's force of habit?

Skinner: Force of habit" doesn't tell you anything Of course it's important to get something published but that's not the reinforcer when you're at your desk The main thing is getting sentences to say what you have to say getting something straight for the first time seeing a manuscript grow And you punish yourself when you discover that a section is badly written and must be done over The critical response after publication undoubtedly has some effect But when say you're practicing on a trampoline it's not the award at the Olympics that makes the difference between coming down right and coming down wrong It's doing it right and not cracking your skull

Omni: You have debated publicly with Carl Rogers, the psychologist Where do you stand on the "ideal person, the desirable end product of any scheme of growth?

Skinner: I think in looking at things such as health and physical and mental enjoyment Carl and I would call the same

> *"I don't believe in "abilities." To say that an artist is creative because he possesses creativity is double-talk. If you look at what he does, you might find out something."*

people successful We would agree that you should enjoy what you're doing do it because you want to rather than because you have to I would put that down to the consequences involved—whether you act to avoid punishment or for positive consequences—but Rogers, as far as I know would talk in terms of the fulfillment of the person We are about as far apart on questions of means as any two people could be, but I think we are quite close on ends

Omni: Have you paid attention to such modification programs as est?

Skinner: Yes Three of my friends have been through it Two of them wrote a report saying that it might have favorable consequences and they felt that it had been so for them I suppose any rather violent episode in one's life might have favorable effects but it can also be dangerous

I'm not going to try to explain the Guyana tragedy or to explain the almost equal tragedies of the Moonies and Scientologists. They're still alive—some part of them, at least—but it's a kind of behavioral death

Omni: People talk loosely about how others have been programmed and need to be deprogrammed How do you feel about this question of reconditioning people?

Skinner: In a way all psychotherapy is reprogramming You aren't curing a disorder, you're adding something to the history of the individual If what you add is powerful enough it will almost certainly lead to different behavior

Omni: One prospect for the design of environments arises in the current discussion of space habitats. that's an area where your work could have important applications Have you talked with Gerard K. O'Neill or others working on that?

Skinner: No although I have thought about it I think it's going to be a long time before space solves the problem of overpopulation here but we are probably going to have space platforms for small populations and their survival raises the question of design If things went bad you'd be in real trouble So you must think very carefully about how people are to interact Wouldn't it be wonderful if we thought as seriously about a classroom a factory or a family? But our sense of the future is still too far away

Omni: Is that because awareness of a future is not a motivation in itself? People can be aware of the connection between smoking cigarettes and lung cancer but it doesn't stop them from smoking

Skinner: It's the whole question of whether remote consequences can have any effect upon people Obviously they can't in a literal sense because a future event does not affect anything But some cultures have managed to give those who belong to them reasons for behaving now in ways that have a bearing on the future Successful cultures give the best current reasons for behaving in ways that make a future possible

Omni: Do you see anything developing in current American attitudes or behavior that might threaten our future? Do you detect any promising signs?

Skinner: If you think about threats to the human species there are many areas in which the United States plays an important role First of all our stockpiles of nuclear weapons and our general unwillingness to reduce them and particularly to make sure that not one nuclear bomb falls into the wrong hands Second our consumption of resources We are using up critical materials and energy at a very high rate compared with the rate of their consumption by, say the people of India This poses a threat to the whole world

However there are things in our favor Our technology is superior to most nations' and we are far ahead in the analysis of behavior No other country comes near us in this field Interest is spreading now but the technology of behavior has been primarily an American achievement If it proves to be the case that our only hope is to catch ourselves before it's too late and to apply scientific analysis to our problems then perhaps we can be forgiven our carelessness in other areas ∞

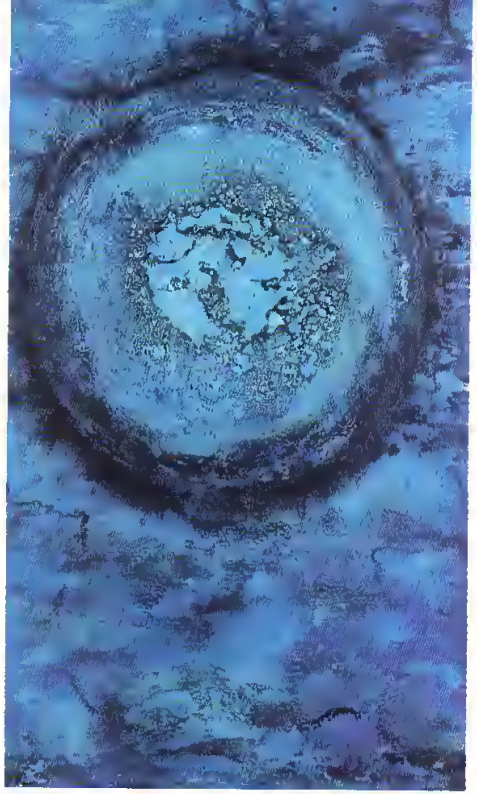

Fossil fuel
STOP MOTOR
NO SMOKING
WE HONOR
REGULAR
UNLEADED
SUPER
DAVID BROWN

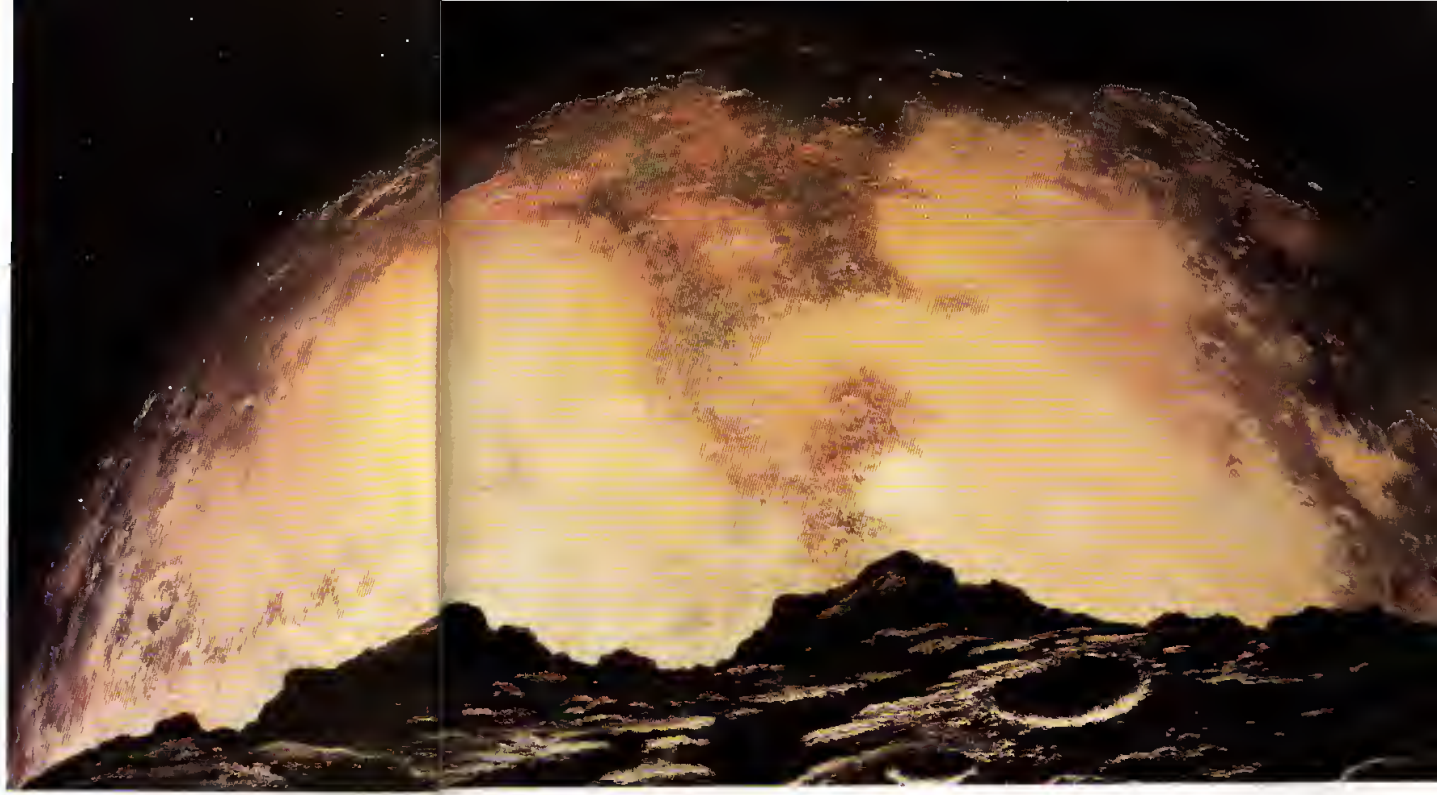
EYEWITNESS TO SPACE

BY F C DURANT III

The artist discerns not only with his eyes but with all his physical senses. Emotional impact adds emphasis, color, and mood to the mental image.

Knight's Armor, *by Paul Calle (left).* Afterthoughts: Gemini *astronaut Gordon Cooper aboard recovery ship, by Mitchell Jamieson (above).*





"Hey Joe! Who are those guys with sketch pads down at the gantry?" The scene: Cape Canaveral, Spring 1963. It was indeed incongruous—artists recording space history in the midst of technicians and the world's most complex and advanced machines. Were not cameras good enough to record these momentous events? No. Too chancy. The lifetime of photographic film and prints—particularly color—was unknown and suspect. Oil paintings, canvas, and inks, however, have survived for centuries. This set the stage for a unique collaboration. To record the manned space program for posterity, James E. Webb,

Clockwise from bottom left: Celestial Journey *by Lamar Dodd, visualizes the distant lunar target for Apollo missions.* Within Saturn's Rings *by Ludek Pesek, a well-known astronomical artist. Czech émigré Pesek now resides in Switzerland.* Moonscape. *Yeffee Kimball's ethereal moon,* Mars from Deimos *by Pesek.*

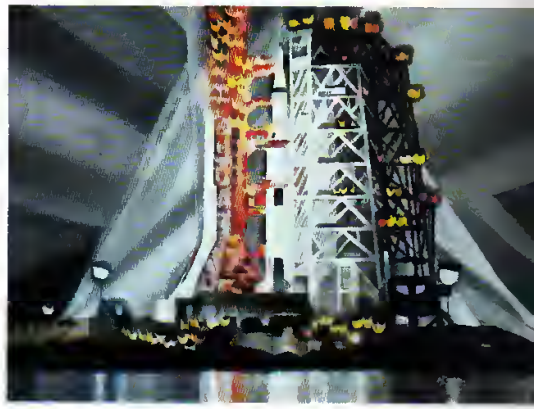
"The artist's vision is colored by memory, technique, and emotional response."

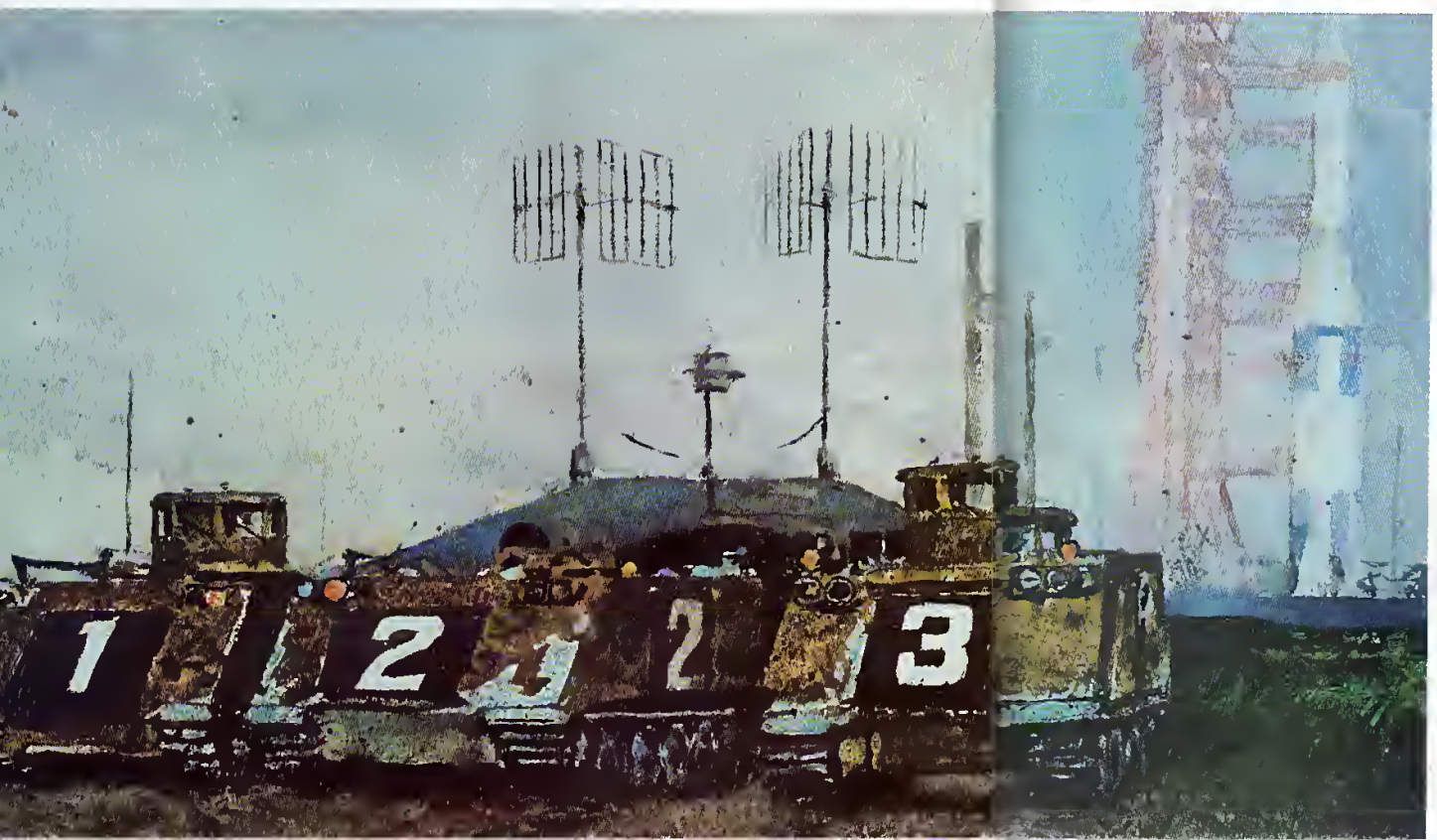
"Wonderfully, each artist sees and interprets the same scene differently"

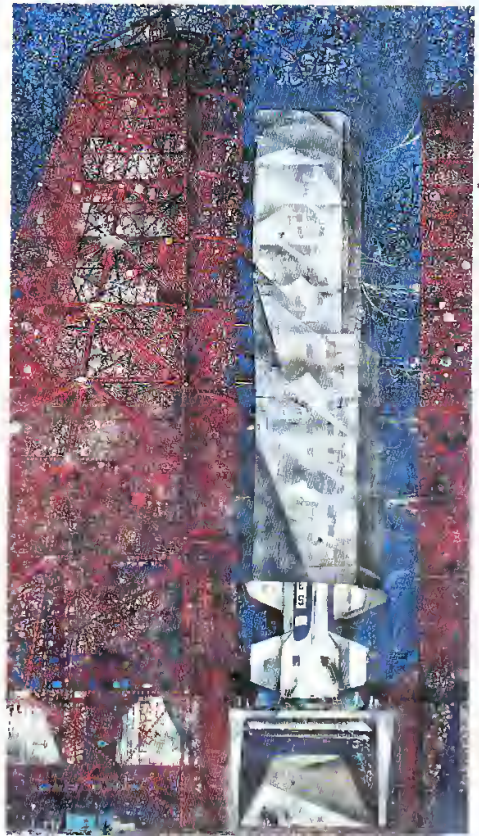
then administrator of NASA, asked H. Lester Cooke (at the National Gallery of Art) to enlist the help of top American artists. Cooke, himself an artist and James Dean, NASA's leading graphic designer, set up a program that resulted in the submission of hundreds of drawings, lithographs, and paintings. Some were illustrative, others abstract.

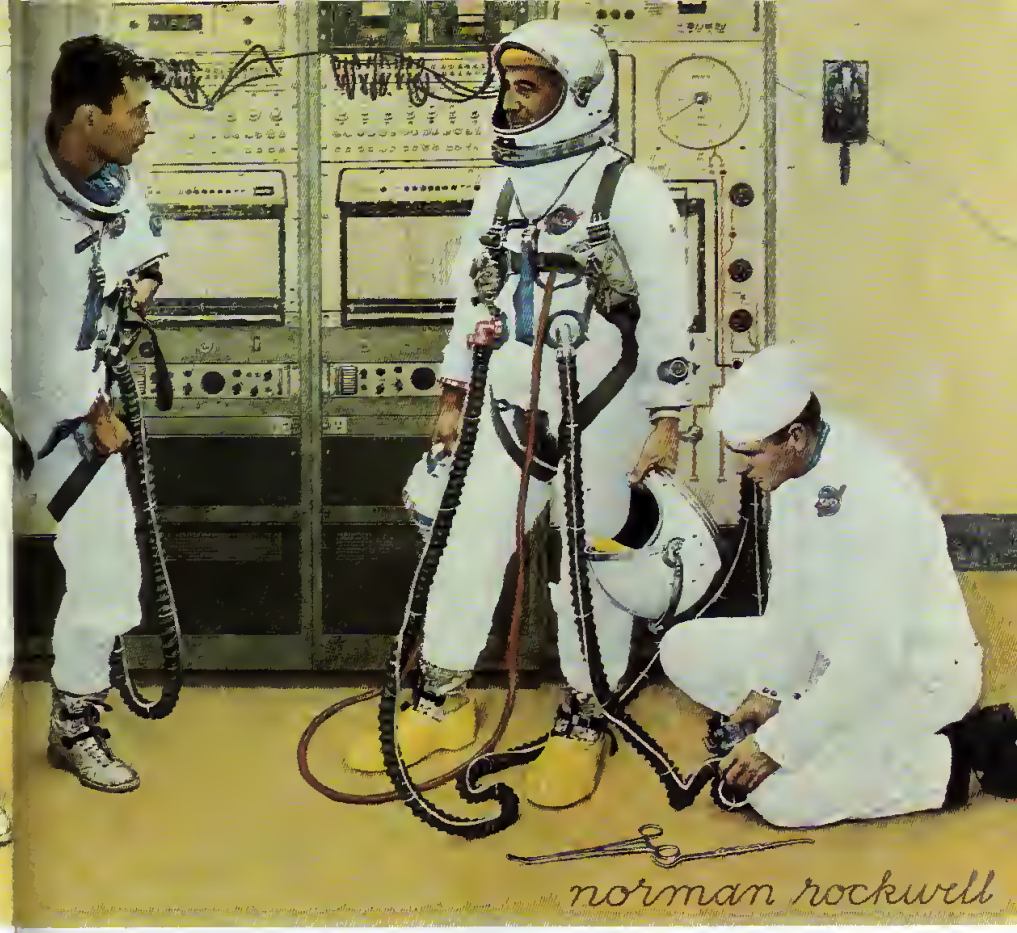
NASA extended to the artists invitations to visit Cape Canaveral for a launch, or Mission Control, at Houston, or to await splashdown aboard a recovery ship. Desired were "emotional impact, interpretation, and hidden significance of these events that lie within the scope of the

Clockwise from right: VAB Bay, NASA's Vehicle Assembly Building in which Lowell Nesbitt looks up into the 150-meter bays. Apollo 11, final nighttime preparations for launch, by Mario Cooper. Ladders, by Mitchell Jamieson. Apollo 11—One, Two, Three, by James Wyeth, rescue vehicles on standby







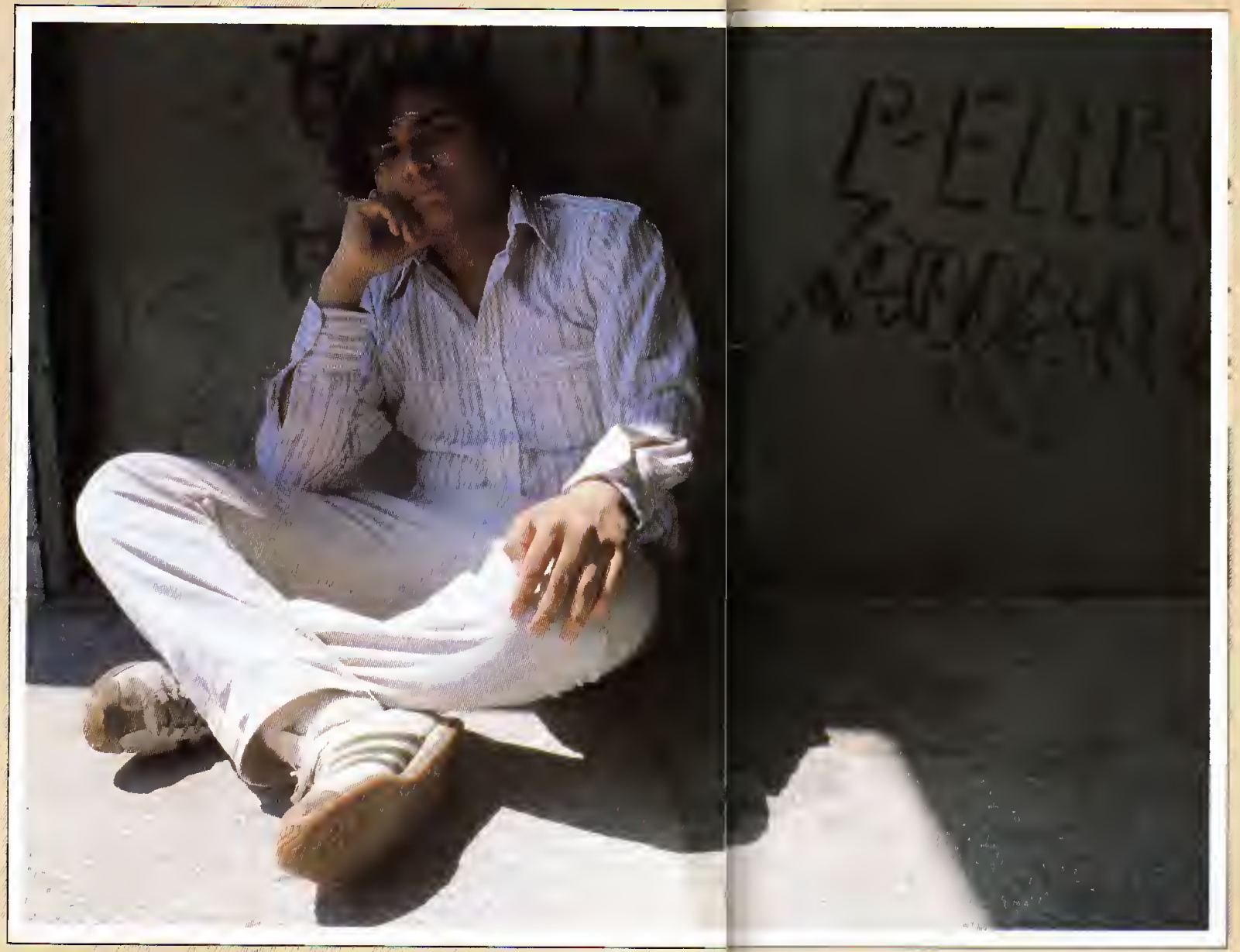


artist's vision." Positive response to these invitations was immediate.

Since 1963 small groups of the finest American artists have interpreted each manned space mission. Next year astronauts Young and Crippen will be launched into orbit aboard the space shuttle, *Columbia*. A select group with sketch pads will be at the Cape, at Mission Control, and at the landing strip in California, recording the event. ∞

Clockwise from left: Weightless, a portrayal of astronauts experiencing free-fall in space, by Robert Shore. First Step on the Moon, by Norman Rockwell. Suiting Up, with astronauts Grissom and Young, oil on canvas, by Norman Rockwell.

American artists will record the shuttle's flight from blast-off to touchdown.



Tomorrow's Einsteins may be among the graffitied walls of a New York high school

SARASWATI IN THE BRONX

BY WILLIAM K. STUCKEY

Alert is too weak a word for *these* students. They gulp a teacher's facts down raw and drink them dry. They are single-minded knowledge cannibals, and you'd better get out of the way. Once, for example, a teacher here—at the Bronx High School of Science—called on a student to solve some mathematical problems at the blackboard, and the student leaped to his feet. Meanwhile, a second student fainted and thudded to the floor. The first student merely stepped over the body and began a Euclidean straight-line course to the blackboard.

On a grassy and suburb-like campus on West 207th Street, not far from the upper-middle-class community of Riverdale or the rugged turf of the Villa Avenue gang, is perhaps the finest public high school in the nation. It is one of a select few that require an entrance examination. Students at Bronx Science are a group of driven adolescents who live to have their I.Q.s (usually around 130) stretched and to post grade averages as close as possible to the ultimate 100. Afterward, they go on to be tapped by the Harvards, Princetons, and Stanfords of the world.

Bronx Science students generally come from households like that of Arani Bose, a seventeen-year-old graduating senior who was born in India. To understand one of the Bose household's rituals is to understand Arani and many of his fellow students. Arani's father, Professor Anindya

Future scientist Arani Bose: 'alert, gifted, and 'detached.'

PHOTOGRAPH BY MICHAEL SOMOROFF

Bose, is an information scientist and former medical illustrator. He once painted, in his spare time, a striking portrait of Saraswati, the Hindu goddess of education and wisdom, which, of course, includes science. Every year, on Saraswati's holy day, the Bose family ritually offers her gifts, in the form of textbooks.

"I've often wondered if Jews aren't subject to similar conditioning," speculates the easygoing principal of Bronx Science, Milton Kopelman. "On high holy days, you know the Torah is taken from the ark and each member of the synagogue kisses it. Perhaps this reverence for the Bible extends to all books. Anyway, it explains a lot of what we see here."

This extraordinary book worship results in an extremely high student grade average. But when a university inquires about a student's grade standing, Kopelman simply doesn't tell.

"Class standings are meaningless here," he says. "In another high school, an average of ninety would put you near the top of the class. Here it would make you about four hundred twenty-fifth out of our eight hundred fifty graduates."

What you *don't* often see at "Science" (the students' appropriate label for their school) is the wild student who writes The Equation on toilet paper, yells for God to come out and fight, scrawls filthy graffiti about Sir Isaac Newton on rest-room walls, and somehow stays sober enough for ten years or so to keep a university job and win the Nobel Prize.

Nor are there many science-fiction readers, although two SF journals are published at the school. "Our kids are rather traditional," explained Mark Rifkin, chairman of the English department, "and they demand the classics." That conservative Science character was highlighted a few years ago when a film on a "possible" space experiment was shown. The students' general reaction was that the experiment was too "farfetched" to carry out. They were then informed that the experiment had already been performed by NASA.

No, at Science you'll find the more stable and systematic type of student, one who takes the experiments and assignments seriously and prefers his or her humor dry. For example, a former student, now a noted astronomer, built a telescope and donated it to Science, naming it Luna C, and one of the headlines in the April Fools' issue of the school paper *Science Survey* (rechristened *Science Scurvy*) read: POOR TURNOUT AT APATHY RALLY. However, there are also juice-filled teen-agers at Science, and occasionally the raunchiness hangs out. *Science Scurvy*, for example, printed a bogus ad that read: "Under 18? You can count on us. Questions about sex, birth control, VD, pregnancy or places to get medical services? Call 555-6969. Facts by phone. Strictly between you and us. FOR A REALLY GOOD TIME, CALL 555-6969."

Those who give second priority to a really good time, however, go on to MIT, Caltech, or other noted brilliance factories to join that top-1-percent elite who shape the future and generally arrange things for the planet. For instance, one alumnus is Leon Cooper, a Nobel Prize winner in physics. Another is Harold Brown, the former president of Caltech, who currently serves as secretary of Defense for President Carter. (One former Sciencer who in the 1960s reached for similar power and failed is the black activist Stokeley Carmichael.) We will soon be hearing from yet another Bronx Science graduate, Professor Steven Weinberg of Harvard, who is a sure-shot for the Nobel Prize in physics for his bold attempt at what Einstein assayed and failed to achieve: the development of a unified field theory. Scratch many university presidents, provosts, deans, and professors—even New York politicians—and you'll find Bronx Science beneath their surface.

Maybe all Sciencers don't run the world, but the world, at least, is watching them closely. Dr. Alexander Taffel, who was the principal of Science for 20 years until his recent retirement and replacement by Kopelman, recalls that a number of Russian delegations came in the early 1960s to observe Science's winning ways. The result is that there are now four educational replicas of Bronx Science in the Soviet Union. Also, there are Science-modeled institutions in the Philippines, Turkey and the distant land of North Carolina, and study delegations from South Korea and the People's Republic of China are on the way.

Scratch many university presidents, provosts, deans, and professors—even New York City politicians—and you'll find Bronx Science beneath their surface.

Certainly the major universities are watching. Science MIT admissions officials report that Science and its prime competitor in New York, Stuyvesant High School—which also requires an entrance exam—are in a dead tie for the title of "American High School That Feeds the Most Freshmen to MIT." And a few years ago Columbia University accepted 100 Sciencers out of a graduating class of 700. (It is rumored around Science that the Columbia admissions official responsible was fired for this, since he failed to apply the proper affirmative-action criteria and instead accepted students who by academic achievement alone appeared to be qualified.)

Sciencers receive extensive practice in the game of science. In addition to being offered college-level courses and broad experimental opportunities, they are trained to write scientific papers and have three high-level school journals in which to publish. Science's facilities include an observatory and a radio station and the first sophisticated computer to be purchased by a high school. Yet experimentation at Science differs sharply from that on the university level in that no student has a government grant. Sciencers must simply scrounge for their supplies and computer time. (One Science wag was spotted wearing a T-shirt saying, I AM A TEEN-AGE SCIENCE HUSTLER.)

Since Bronx Science is part of the New York public-school system—an unusual part, however, to which a number of students in private and parochial schools transfer—it doesn't have a flashy PR department to prepare its lists of "firsts" and "mosts" and keep the lists up to date. However, one can gather random data, collected from the memories of Science's faculty that give a rough idea of the school's position in the world of scientific achievement.

For instance, a twenty-year-old study (never updated) placed Bronx Science first in the nation on the basis of the number of graduates who went on for doctoral degrees in science (and it was noted that only 60 percent of Science's graduates entered into careers of a scientific nature).

Another way to judge Science's impact is the Westinghouse Talent Search, which receives about 15,000 experiments, papers, devices, or demonstrations from the nation's adolescent research hopefuls each year. Of these 15,000, only 40 go on to become national finalists. In the almost 40-year history of the Talent Search, Science has far outstripped every other American high school in the number of its finalists (74). In 1979 four Sciencers made the top 40: Brian Sheppard for mathematics and three students for biology: Ken Liu, Samuel Shaffer, and the star of this story, that typical Bronx Science quality product, that not-the-top-but-near-the-top systematic and stable student and researcher, that prober into the chemical mysteries that underlie memory and learning, that devotee of the goddess Saraswati, Arani Bose.

Fifteen years ago Arani's top-achieving counterpart at Science would have been Jewish. About 85 percent of the students who scored well on the entrance exam were Jews. But many of the Jews moved to the suburbs, and the egalitarians of the 1960s (who now probably hope their children will be accepted by Science) began to raise hell about "elitism" at the school. Particularly galling to them was the entrance exam, which they described as out of place in a public-school system (8,000 students take it each year, 1,000 are accepted). An effort to create a Science-type entrance

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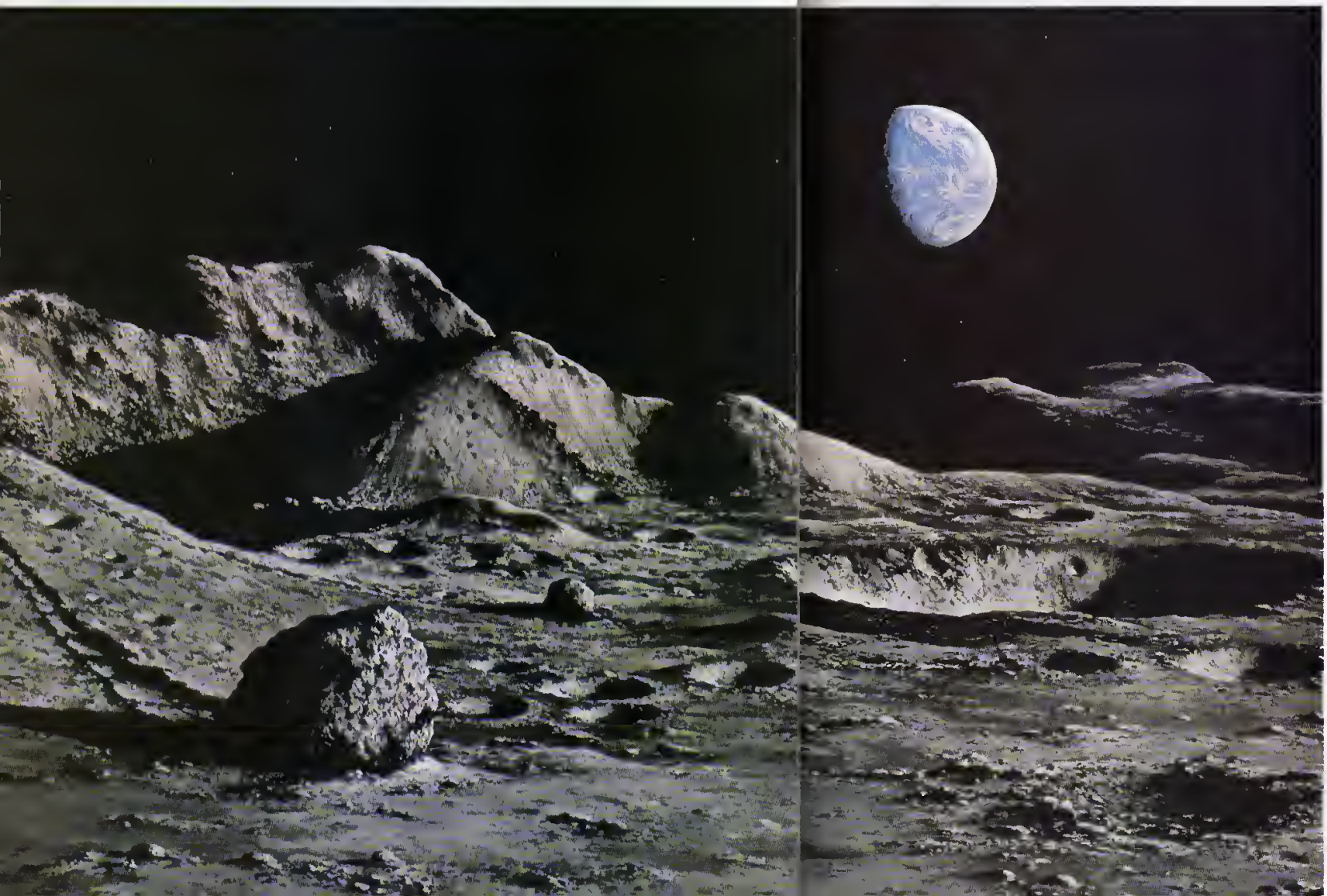
SUPER
MEDIA



FICTION

It was an innocent little "outing"—on the bare lunar surface

THE VACUUM-PACKED PICNIC

BY RICK GAUGER

As she approached my table across the pilots' crowded ready room with her teacup in her hand, I felt an urge coming over me. I had an urge to bite her—on the smooth ivory neck, which emerged from the heavy aluminum collar ring of her close-fitting pilot's vacuum suit. Maybe it was the way she jangled all those pockets, tubes, clipboards, and electronic terminals as she made her way through the mob toward me. The typical space pilot's swagger—but female. Maybe it was the merry brown eyes and the humorous twist of her lips as she sat down in front of me.

"You're Captain Suarez, aren't you?"

"Yeah. My friends call me—"

"Pancho. Right?"

"Right. I hope you're one of my friends," I said, my figurative tail wagging furiously. Worst case of vibes I'd ever had. It seemed to be mutual. She studied me amusedly while her tea cooled.

I said, "Surely we've never met before. I know I'm pretty absent-minded, but—"

"Your friend Arunis Pittman told me about you. I met him on the polar sky station. He thought I should look you up."

PAINTING BY LUDEK PESEK

when I got to West Limb. He said you would probably offer to keep me amused. You were highly recommended."

"Old Arunis! Damn! How is he?"

"He's fine. He said I should ask you whether you're still keeping the CO_2 high in your spacecraft life-support system instead of doing the regulation aerobic exercises, the way you're supposed to."

"Damn again! How could he know about that? I'll bet he's trying to warn me that the agency is monitoring my life-support system again. I appreciate that. Thanks, Captain . . . er . . ."

"Cramblitt. I prefer Stacy, however." After a pause she asked, "Well, are you?"

"Not anymore. I don't want to be grounded again. I'll do my exercises like a good boy—"

"I don't mean that," she said. "I mean, are you going to amuse me? This is the first time I've been on the moon. I don't have anything to do until the passenger shuttle begins its preflight countdown tomorrow night."

An opening big enough to drive a truck into. I had to think of something immediately, that would capture her imagination. She tucked an errant strand of glossy black hair into her chignon as my mind raced.

"A picnic. How would you like to go on a picnic? With me," I said, blurting out the first idiocy that came into my mind. "If you like, I'll take you to one of my favorite spots. It's not far, just a short walk from the base."

Her reaction was everything I could have hoped for. Her delicate mouth dropped open a little. "You're kidding. An *outdoor* picnic?"

"Why, sure," I lied. "It's a new recreation we have come up with here on the moon. Gets us away from the madding crowd. A great view, the hills, some nice rock colors. Perfect time of the month for it, too." Bridges were flaming behind me. *Why do I do these things?* "Of course you'd probably rather not go to the trouble. You're probably too tired, right?"

Her excitement showed on her face. Her eyes began to twinkle. "Oh, no! I wouldn't miss this for anything!" she exclaimed. "A picnic on the moon! That's fantastic! Arunis was right about you, Pancho."

"Aw," I mumbled, standing up and giving her my boyish grin. "Just leave it all to me. Meet me at Hatch Seven-Charlie—anyone can tell you where it is—at ten hours tomorrow. Put on your vacuum suit and bring a fully charged backpack. I'll take care of the rest. I have to make a hopper run now. See you then."

Her smile followed me across the ready room as I made my way to the hopper dock. I waved goodbye before turning into the corridor. Male residents of the base who happened to be in the ready room watched all this enviously. They didn't see the grimace that appeared on my face as soon as I was out of sight. I had really jumped into it with both feet this time.

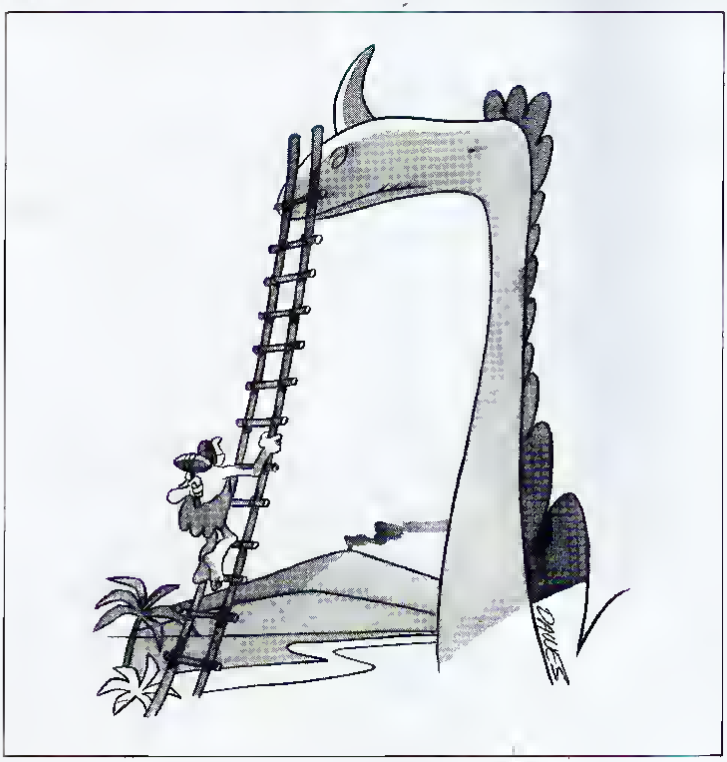
Well, the business I had handed her about a picnic wasn't one-hundred-percent baloney. No one had ever really been on a picnic on the moon before, but the West Limb intellectual elite (my pals and I) had been discussing the idea for quite a while. We regarded our project as a noble pioneering effort, an expansion of man's capability in the space environment, but mainly, as a way to get some privacy with our female colleagues. The base at West Limb hadn't yet become the luxurious suburb that it is today. In those days it was more like a big locker room on the moon: a crowded, noisy set of tunnels and domes, which reeked of old socks and new paint. We all lived in this warren like so many rats in a hole. The transients among us, from months of isolation, were nearly barbarians, while the permanent residents were antagonistic from never being able to get away from one another. Life on the old high frontier was rough, yes sir!

Unfortunately, plans for outings *à deux* hadn't gotten past the speculative stage yet. One of my friends had analyzed the problem of picnic-site selection. Using lots of stolen computer time, he had determined which areas on the lunar surface around West Limb could be inhabited by a man—and a woman—for a reasonable length of time in a standard vacuum-survival tent. Of course, the idea was to obtain a comfortable shirt-sleeves-or-less habitat.

You know what survival tents are. They're what's inside those emergency boxes you see everywhere on the moon. Buggies have to carry one per passenger, so do the rocket hoppers. You've undoubtedly got several small ones under the bed in your hotel room. Solo prospectors and other outdoor workers use them regularly when they can't get to any other pressurized shelter. They climb into a tent, seal the opening, and inflate it with their reserve air. The tents blow up into a transparent plastic dome. Once the dome is pressurized, you can take off your vacuum suit and relax a bit. The old-timers say they're for leaks, whether you get one or have to take one. That's a joke.

Anyway, the most important element of my friend's analysis was the temperature inside the tent. Sunshine was everything. Anyone exposing his ass to the direct rays coming through the plastic would be rapidly rump-roasted. Complete lunar nighttime would be a glacial and gloomy experience, to say the least. No, what we wanted was a cheerful, sunshiny, picnicky sort of experience, with lots of scenery, close to, but not in sight of, the base or any of the main trails. A flat, shady spot on a slope facing a sunlit landscape, with an illuminated boulder nearby to reflect warmth toward the picnickers, would be ideal.

The computer in my friend's office, properly (and illegally) stroked, coughed up a number of map overlays, one for each



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E.P.A.
CLEAN
UP
CREW
SERILO

FOOD FOR ZERO

I gave up my dream of becoming an astronaut the first time I tasted Tang. Space food, born of camping supplies and military survival rations, has never appealed to me. No grapefruits, no popcorn, no beer. Nothing freshly cooked, either—just a long, elaborate picnic packed on Earth.

Thus far I have avoided conscription into the space program, being a mere child when the Mercury missions began and now a woman with no experience in the military, or even in a sleep-away camp. Even if I never fly on the space shuttle (probably a sure bet), I may still wind up working at a space station or moving to an extraterrestrial colony. And there, according to the latest projections from the National Aeronautics and Space Administration (NASA), a box lunch of dehydrated bananas will be heaven compared with other future foods fabricated from human wastes. I'm convinced I'll get used to them, though, beating down my cravings for raw string beans as successfully as I've beaten down my desire for cigarettes.

And all of you who don't plan to meet the challenge of the Space Age, how long do you think you've got before the real orange juice runs out? Land to grow food on will soon be rarer than gasoline is, and grocery shelves will be stocked with more products like instant breakfast, processed food sticks, and imitation-cheese spread than ever before. Even if you never leave the one-g tug of Earth, your diet is bound to include the foods designed for zero-g conditions en route to the moon and beyond.

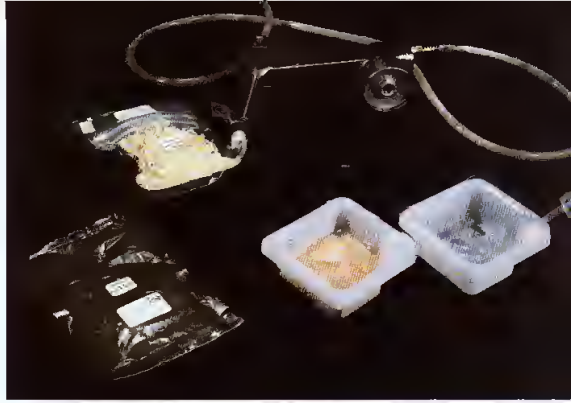
Space-food scientists and commercial-food technologists are cooperating on a regular basis now, sharing each other's research successes. NASA will stock the space shuttle galley with products from Carnation, Coca-Cola, Del Monte, General Mills, Green Giant, Hunt-Wesson, Keebler, Kellogg's, Kraft, Nabisco, Nestlé, Pepperidge Farm, Pet, Planters, Starkist, and Stouffer. The only things that will allow us to distinguish space food from commercial food will be its special packaging, longer shelf life, and the abundance of items whose thick gravies or sticky sauces bind them together in the absence of gravity.

Before John Glenn became the first American to eat in outer space 17 years ago, no

It is easier to launch a thousand ships than to send a single meat loaf into space without dehydrating it

BY DAVA SOBEL

PHOTOGRAPHS BY J.L. LONG ASSOCIATES



one was sure that man could swallow food in zero-g. Many observers had judged the feat impossible, fearing that Glenn would choke in the effort, contract foreign-body pneumonia by inhaling food particles or droplets, or find himself unable to digest and absorb nutrients in a weightless environment. These ideas couldn't be tested preflight because no earthbound simulator was capable of mimicking zero-g.

It turns out that eating and eliminating posed no problem, but containing foodstuffs and wastes in zero-g did. Early space foods were engineered as carefully as spacecraft, built to maximize nourishment and convenience, with little flavor and absolutely no aesthetic appeal. And all the end products of eating—urine and feces—returned to Earth for complete scientific analysis.

Pureed concoctions went into space first, packed in silvery toothpaste tubes with a durable straw that the astronaut could pass through the feed port in his helmet. Marooned inside his pressurized suit, he had to squeeze his meals into his mouth without seeing or smelling what he was eating. Dining this way was barely one step above intravenous feeding, because without color cues, aromas, or differences in texture, nobody can tell tuna from tomato.

As the Mercury missions continued and improvements in design allowed the astronauts to remove their helmets inside the spacecraft, they advanced from sucking to chewing on all manner of bite-sized cubes: coconut cubes, peanut cubes, bacon squares, brownies, chicken-sandwich bites, potato-chip blocks, even fruit-and-cereal combos and cinnamon-toast tidbits, each coated with gelatin or a mixture of protein and oil that reduced crumbling and added extra calories. (A man may require less energy for locomotion in zero-g, but performing even simple tasks without benefit of friction makes extra work for his muscles. To flip a switch while weightless, an astronaut has to grab a handhold first. Test he flip himself as well. Some astronauts consumed as many as 3 000 calories a day

Preceding page: *Skylab* warming tray holds (Row 1) turkey-and-rice soup, chili, asparagus. Row 2: strawberries, biscuits, orange drink. Row 3: nuts and pudding. Above: On shuttle test flights, food will be packed in suitcase-sized container. Top right: Simple square containers, proposed for shuttle galley, are compared to rehydratable package and its apparatus (at top) and earlier thermostabilized package (left). Center right: Rehydratable veal sauce (left) is compared with thermostabilized turkey. Bottom: *Gemini* astronauts ate cubes of bread, cheese, cereal, chicken sandwiches.

in space and still managed to lose weight.)

Astronauts could pick cubes out of a plastic casing or pop them into their mouth with a spring-action dispenser. All cube foods were dry; their bulky natural moisture removed to reduce the expense of launching them. (Even in the 1960s it cost NASA $75,000 to place one pound of anything into orbit.) Of course, the astronauts had water to drink but only their saliva to wash down the food cubes—like eating cornflakes without milk.

Although no official meals were launched on the short flight of *Gemini 3*, a corned-beef sandwich from the celebrated Wolfie's Delicatessen in Cocoa Beach, orbited the earth with John Young and Virgil Grissom. It had been smuggled aboard the spacecraft, surreptitiously brought and handed to Young on the launchpad by fellow astronaut Wally Schirra. Young kept the sandwich in a zippered leg pocket of his spacesuit until splashdown, when he offered it to Grissom, who ate it while waiting for the rescue ship. They were both immediately sorry. For as any astronaut will tell you, *Gemini 3* wasn't much of a boat, and it pitched about sickeningly in the waves.

During later Gemini missions, changes in spacecraft technology facilitated improvements in space food. New fuel cells, which generated electrical energy in flight, released water as a by-product of their normal operation. The astronauts were able to use the running water to rehydrate or reconstitute anything from powders like lemonade and cocoa to freeze-dried pot roast. They shot water from a narrow-nozzle gun through a one-way valve on each plastic food packet, shook or kneaded the "zero-g feeder" until the contents were well mixed, inserted the mouthpiece, and rolled the envelope up from the bottom to serve themselves. They ate all their meals at room temperature, too, since the reconstitution water never got warmer or cooler than 26.6°C. There was no hot water in space until *Apollo 7*, and even then the food didn't stay hot during the 10 or 15 minutes needed to rehydrate some items.

By the time the *Apollo 8* crew was ready for the first Christmas dinner in space, NASA's food specialists had learned enough about zero g to serve a traditional holiday meal that could be eaten from a food pouch, with a *spoon*. Foods with the right degree of stickiness adhered to one another and to their containers enough to be lifted into the mouth like Earth food, to let their aromas out at last, and to go aloft in their own juices; the weight penalty was justified by the crew's pleasure.

"Hello, Houston, *Apollo 8*," Commander Frank Borman radioed back on Christmas night 1968. "It appears that we did a great injustice to the food people. Santa Claus just brought us a dinner each, and it was delicious. . . turkey and gravy, cranberry sauce, grape punch. . . . Outstanding!"

And then nausea and vomiting on *Apollo 9*, caused by motion sickness, had the astronauts appealing for a way to make on-the-spot menu changes, so a queasy astronaut wouldn't have to eat that day's assigned meals. One mission later, an onboard pantry appeared, containing slices of bread (prepacked in a nitrogen atmosphere so it would last at least four weeks) and tins of meat-salad sandwich fillings, as well as mustard, ketchup, peanut butter, and jelly.

Thermostabilized frankfurters landed on the moon with *Apollo 11*, freeze-dried scrambled eggs with *Apollo 12*. And *Apollo 13*, though it never reached the moon, carried enough water-containing foods to keep the crew alive during the emergency that crippled the spacecraft's fuel cells. Also, the first dehydrated *natural* orange juice flew on *Apollo 13*.

While touring the lunar surface, *Apollo 14* astronauts refreshed themselves with in-suit drinking devices that hooked a portable beverage bag (they called it Gunga Din) to a mouthpiece with a tilt valve inside the helmet. And *Apollo 15* explorers fared even better, snacking on high-nutrient food bars installed right in the neck rings of their moon suits. This no-hands system worked well until Charles Duke, *Apollo 16*'s lunar-module pilot, spilled some orange drink inside his helmet, where it matted his hair and nearly interacted with the visor-defogging compound.

"I wouldn't give you two cents for that orange juice as a hair tonic," he quipped.

On the final flight to the moon there was shelf-stable ham steak, sterilized by irradiation with cobalt-60, and nutritionally complete fruitcake, designed to last indefinitely packed in ready-to-eat moist form, and apparently palatable, too.

What had once been achieved by food processing could now be handled by package processing. A better cookie container allowed dietitians to launch a Pecan Sandie or a graham cracker without first compressing it into a cube—to the crew's everlasting delight. The sugar cookies on *Skylab*, in fact, were such a hit that the astronauts laughingly hoarded them and bartered with them.

Skylab boasted the most varied and well-tolerated menus that astronauts had ever enjoyed. Real heated food was available in space for the first time. Each crew member picked his own meal plan, and for six days he would not have the same dinner twice. Even so, the men complained of "wandering flavors." They ate their *Skylab* provisions on the ground for 21 days before the mission and 18 days afterward, yet some found the foods tasted inexplicably blander in space. One possible explanation is that the zero-g environment allows more fluid to fill the head, and this condition may dull one's taste sensations.

"What I missed most," recalls *Skylab* science pilot Ed Gibson, "was pepperoni pizza."

Because *Skylab* was an extended exper-

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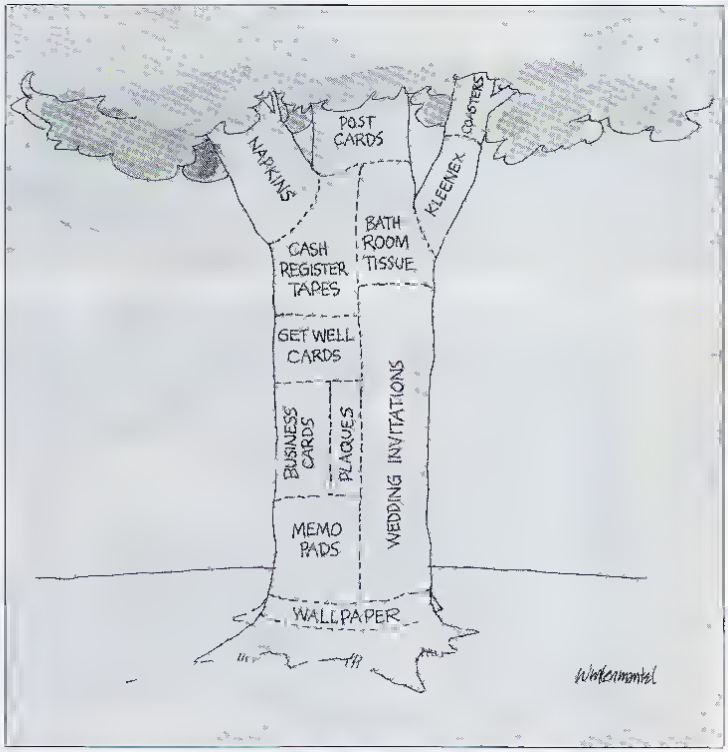


HOVIK-79

'DOC'

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using the pinger for subbottom seismic probes, making photoprofiles of objects under the seabed; these were pictures made electronically with sound instead of with light.

Doc's pinger and later "boomer" instruments completely revolutionized underwater archaeological research. Edgerton and Cousteau used them to find the wreck of H.M.S. *Britannic*, torpedoed in the Dardanelles during World War I and later they were used on Cousteau's long search for possible sites of Atlantis. After his retirement, Doc turned to sonar almost full time. "Photography had gotten boring for me," he said. "It seemed as if everyone else was doing it, and it just got very limiting. With sonar you can go ten times further, and that's the kind of exploration I like. The last part of the world to be explored is underneath the floors of the oceans. It's our last real frontier. With our hydrographic methods we know what's on the surface of the bottom, but not what's underneath. And that's where we're starting to find interesting things."

Things like the lost Greek city of Helice, sunk in the Gulf of Corinth, which Edgerton has been exploring since 1966; like a series of sunken Phoenician vessels, which Doc found while he was helping some Israeli cartographers map their sea floor; like the ironclad *Monitor*, like the 100-year-old merchantman that Edgerton found in the muck below Lake Champlain last summer; and like the mysterious stone circles he accidentally discovered on the bottom of Loch Ness while he was hunting the monster in 1975.

It was also one of Edgerton's camera-strobe systems that got the fabled blurry (but undeniably *something*) underwater photos of Nessie that year under the auspices of Boston's Academy of Applied Sciences (AAS).

The first record of some kind of creature in the loch dates from A.D. 565, when Saint Columba is alleged to have frightened one off. Ever since, people have been seeing things moving along the surface, usually described as about six meters in length, with a couple of humps and a long neck topped by a small head. Tourists and monster hunters have produced pictures of Nessie from time to time. However, none has ever proved indisputably to be a picture of the animal.

Enter Doc Edgerton. In 1972 he lent the AAS a camera-strobe system that he'd originally built with Geographic Society money to take time-lapse movies of aquatic life in Boston Harbor. The system snapped a picture underwater every 30 seconds. Fully loaded, it could take 2,000 strobe-lit pictures in 24 hours. That summer's work yielded some tantalizing data, including a sonar-trace presence of large moving creatures but nothing concrete. Three years later, Doc incorporated new techniques into a sonar-triggered system that was duly lowered onto an underwater shelf in the loch during the summer. Edgerton's original 1972 camera was also deployed on the shelf as a backup system.

The main camera was later found to have been blocked up by silt that had been stirred up when the sonar again indicated large moving objects near the apparatus. But the old backup camera scored big. One of three frames (out of thousands) contained what was interpreted as a close-up of Nessie's face, complete with bilateral symmetry and several hornlike projections over the eyes, taken at a distance of about 1.5 meters. Another showed what appeared to be the upper torso, neck and head of the creature about 7.5 meters away. One looks at the "head" shot in utter disbelief. It resembles a demon or an evil spirit more than anything else.

To me, those pictures are really terrific," Edgerton said exultantly. "It's true that the quality [of the pictures] is terrible, but the really important thing is that they're genuine. There seem to be a lot of people who think the whole Loch Ness story is fake, and you can get better pictures of the creature from them than you can from the real thing. The fake pictures are justifiably part of the skepticism. But these are *real*."

Real enough for Edgerton and the AAS to conclude (in MIT's *Technology Review*, March 1976) that "Taken together . . . the 1975 photographs and the sonar evidence . . . agree that there is a species of large aquatic creatures in Loch Ness." They named this species *Nessiteras rhombopteryx* and published a picture of one of them on the front page of *The New York Times*.

"Hi Mom! Hi Dad!"

OLD TECH PERSONA

Many of Edgerton's colleagues and students tend to describe him as being very "Old Tech" (at MIT this means he is one of the last of the gentleman scientists). I discovered the significance of this last January, when Edgerton conducted a week-long lecture series in one of his Strobe Alley classrooms. The lectures were part of MIT's free-form Independent Activities period, during which students are encouraged to take an interest in matters outside the scope of their usual pursuits.

True to his reputation as a teacher who arouses obsessive curiosity in students, Edgerton packed them in. Long-haired undergraduates, serious graduate students, and ultrarespectful visiting professors from all over the country filled the chairs and stood several rows deep at the back of the room as Doc, attired in his customary tweeds (but sporting a jaunty silver "Monitor Expedition" belt buckle), expounded in his folksy manner on the various areas of his interest—strobes for ornithological-research photography, xenon flash lamps, the magneto-optical strobes used for underwater archaeology. His style

was relaxed and plain. Using humor and anecdotes that evoked the Old Tech days, the lectures were basic how-to, hands-on advice for anyone who grasped the basics of strobe-assisted photographic techniques.

Every question received a detailed answer and understatement was the rule. If Doc likes something, he says it's "very interesting." Someone asked him his theory on some subject, and his kindly midwestern features cracked into a dry, homespun grin. "Oh, no theories here, please. I'm just an experimentalist."

Anyone auditing an Edgerton seminar is immediately impressed by the superb rapport Doc shares with his students. There's never a trace of condescension in Doc's manner as he banters and trades observations and techniques with undergraduates more than 50 years his junior. In fact, Doc does his best to put the kids at ease and make them feel at home. He and his wife, Esther ("Mrs. Doc," as she is also known), live just off campus, and their doors are as open to students as if Doc were still rooted in rural Nebraska. Equally legendary are the electrical engineering department steak-and-beer feasts at the end of each term, during which Doc is given to strolling among the diners with his guitar strapped on, serenading them with his favorite country and Western tunes.

"I'm really *scared* of the students," Doc says. "A lot of them are more brilliant than I am supposed to be. Tremendous amount of people from all over the world, all kinds of backgrounds. Some of them come to class and know more than I do about the projects I'm working on. I don't consider myself much of a teacher, but I always try to bring in practical things, give demonstrations, get their hands on things. Because MIT is noted for people who get up there and slap integral signs and differential signs and equations all over the board and nobody knows what it's about. And when you get through and learn this fancy stuff—but if you have to fix a fuse or solder a wire, you don't have a trade."

"What we mean by 'Old Tech,'" says Edgerton's friend Professor Jerome Lettvin, "is that MIT used to be a place that was a lot of fun. You worked on whatever you pleased, worked hard, and got big kicks. There was a 'fun with nature, go ahead-and-do-it' attitude in the old days. Your work was unstructured. No problem was too small or too large. You made a booboo, you made a booboo. So what? That was the atmosphere that Doc came up in and helped create. You'd build your equipment out of shoe boxes, your work wasn't highly cost-accounted and specialized. And everyone was a gentleman scientist then. People were fascinated by one another's work. Criticism was free and easy and often valuable. It was much less of a shoe factory.

"When did all that change? I suppose when the great armed-services contracts began to dry up in the early Sixties. Now we're very bound into the common reality of dollars and cents. Nobody has that old freedom anymore. Being at MIT used to be like swimming in a big, open, free ocean. Now it's more like being in a very complicated swimming pool."

Why, I asked, has Edgerton, though much honored, not received the Nobel and other major international prizes for the strobe and other inventions?

"Because Doc is a rare bird," Dr. Lettvin said. "He doesn't want prizes. He doesn't care a bit about appearances and stature. He doesn't even bother with patents anymore. Edgerton is just a man who really enjoys his work."

FUTURE VIEW

After the lectures, I cornered Doc in his office one afternoon to talk about the future of his work. He sat amid a cluttered jumble of framed photos, ancient Greek amphoras on tripods, and underwater cameras, sonar and housings in various stages of construction. So what does the respected professor have to say about the future?

"Well, of course, the strobe is here to stay. It's everywhere you want quantized energy to do a certain job. I was watching a demonstration of phototypesetting the other day that was very interesting. And of course the strobe is being used in space. Buzz Aldrin was a student here, and he worked on the strobe beacon system for the Apollo missions. When you're flying around in outer space, everything is black, and all you have to go on are little pinpoints of light. If you want to rendezvous with something, it's important that you be able to pick it out. Strobes do the trick."

As we talked about the future, a medical student dropped in to chat with Doc about a cure for the herpes virus that he was working on, using an infrared laser-strobe system to kill viruses that had been treated with a special dye. So strobe-related research continues all the time. Experimenters have obtained pictures of dynamite-cap blasts at 10^{10} second, and the laser people have gone down to 10^{16}, but they haven't yet found any practical application for it. Edgerton says he's more interested in underwater archaeology these days and doesn't have much to do with strobes anymore. He did admit, when pressed, that the previous day he had sketched out some ideas for a new lamp to increase the efficiency of an underwater plankton camera he'd been working on in recent months.

Before I left, I asked him what his immediate plans were. He said he was going back to the Gulf of Corinth, for the sixth time, to look for Helice. "My wife's complaining that I'm seventy-six years old and retired and I ought to quit working Saturday and Sunday. But I can't help it anymore. If you're stupid enough to be persistent in this kind of job, you usually get what you're looking for."

"If you're an organic chemist, why are you wearing polyester?"

KINSMAN

CONTINUED FROM PAGE 55

soon enough. Come on. Hurry it up."

Reluctantly Kinsman turned away from the stars and back to the dark interior of the payload bay. Colt trailed behind him. Working with Captain Howard, they set the satellite on the shuttle's payload-deployment arm, a long metal boom that swung the squat drumlike mechanism up and completely outside the emptied cargo bay.

"Good work," Howard said. He touched his keyboard and reported back to the flight deck.

"Now we wait," he said to Colt and Kinsman. "You guys were so good, we finished eight minutes ahead of schedule."

Kinsman felt himself smiling at the captain. Not that they could see each other's faces through the tinted visors. But something had softened Howard. *He's just as wiped out by all this grandeur as we are. Only he won't let his emotions show.*

They switched their suit radios to the flight deck's frequency and listened to the final orbital maneuvering that placed the shuttle in the right spot for launching the satellite. Twice the control jets at the rear of the ship, near the root of the big tail fin, flared—such quick puffs of light that they were gone before they had truly registered on Kinsman's eyes. When the moment came to release the satellite, it was utterly unspectacular.

"... three, two, one," said Major Jakes's heavy voice.

There was no sound, just a brief puff of escaping gas as the tiny thruster built into the bottom end of the satellite pushed the drum away from the boom arm. The satellite quickly dwindled into the distance and disappeared among the stars.

As the boom swung back inside the payload bay and folded itself into place along the deck, Captain Howard said, "Now for the final chore. It's a big one, we've been saving it for you boys."

Kinsman tried to glance over at Colt, but when he turned his head, all he saw was the inside lining of his helmet.

"You were too excited to notice," Howard was explaining, "but we haven't detached the booster fuel tank that we rode up on. It's still strapped to the orbiter's belly."

"Can't reenter with that thing hanging onto us," Colt said.

"Right. We have no intention of doing that. We're heading now for a rendezvous point where the last six missions have separated their booster tanks and left them in orbit. One of these days, when the Air Force gets enough astronauts and enough money, we're going to convert all those empty tanks into a permanent, full-sized space station."

"I'll be damned," Kinsman said, grinning to himself.

"Your mission," Howard went on, "is to separate our tank and attach it to the assembly that's already there."

'Simple enough,' Colt said. 'We did something like that at the neutral-buoyancy tank in Alabama.'

'It sounds easy,' Howard said. 'But I won't be there to help you. You're going to be on your own with this one.'

'Okay,' Kinsman said. 'We can handle it without any trouble.'

Howard said nothing for a long moment. Kinsman saw him floating before them, his dark visor looking like the dead, empty eye of some deformed cyclops.

'All right,' the captain said at last. 'But listen to me. If something happens out there, don't panic. Do you hear me? Don't panic.'

'We won't,' Colt said.

What's he worried about? Kinsman wondered briefly.

But he put the thought aside as Howard began testing them on their proficiency with their suit-maneuvering units. They jetted themselves back and forth along the length of the empty payload bay, did pirouettes, planted their feet at precise spots that the captain called out to them—all on puffs of cold gas from the pistollike thruster units.

'There'll be no umbilicals or tethers on this task,' Howard warned them. 'Too much tankage hanging around to foul up your lines. You'll be operating independently. On your own. Do you understand?'

'Sure.'

'No funny stuff and no sightseeing. You won't have time for stargazing. Now fill your propellant and air tanks. I'm going inside to check with the flight deck.'

'Yes, sir.'

'He's pretty edgy,' Kinsman said on their suit-to-suit frequency after Howard had disappeared through the airlock.

'Just puttin' us on, man.'

'I don't know. He said this is the most difficult task of the whole mission.'

'That's why they saved it for us, huh?'

'Maybe.'

He could sense Colt shaking his head, frowning. 'Don't let 'em get to you. He had other jobs, like inspecting that Russian satellite. That was tougher than what we're gonna be doing.'

'That was a one-man task,' Kinsman said. 'He didn't need a couple of rookies getting in his way. And the Reds probably have all sorts of alarm and detection systems on their birds.'

'Yeah, maybe.'

'He's a strange little guy.'

'You'd think he'd have made major by now,' Colt said.

'Or light colonel. He's as old as Murdock. Maybe older.'

'Yeah, but he's got no wings. Flunked out of flight training when he was a kid.'

'Really?'

'That's what Art was telling me. He's nothing more than a glorified tech specialist. No academy. Lucky he made captain. He was almost passed over.'

'No wonder he looks pissed off most of the time.'

'*Most* of the time?'

Kinsman said, 'I got the feeling he enjoyed watching us go bananas over the stars.'

'Hey, yeah, I forgot all about that.'

Kinsman turned and rose slightly off the deck plates so that he could look out at the sky again. *How quickly the miraculous becomes ordinary!*

'Sure is some sight,' Colt said from beside him.

'Makes me want to just drift out of here and never come back,' said Kinsman. 'Just go on and on forever.'

'You'd need a damned big air tank.'

'Not a bad way to die, if you've got to go. Drifting alone, silent, going to sleep among the stars.'

'That's okay for you, maybe, but I intend to be shot by a jealous husband when I'm in my nineties,' Colt said. 'That's how I wanna go: bare-assed and humpin'.'

'White or black?'

'The husband or the wife? Both of 'em honkies, man. Screwin' white folks is the best part of life.'

Kinsman could hear his partner's happy chuckling.

'Frank,' he asked, 'have you ever thought that by the time you're ninety there might not be any race problems anymore?'

Colt's laughter deepened. 'Sure. Just like we won't have any wars and all God's

"Goodnight, men. Don't push any buttons I wouldn't push."

chillun got shoes That's just how it'll be

'All right there it is," Captain Howard told them

The three men were hovering just above the open clamshell doors of the payload bay looking out at what seemed to Kinsman to be a giant stack of beer bottles *Except that they're aluminum not glass*

Six empty propellant tanks, each of them nearly twice the size of the orbiter itself, were arranged in two neat rows From this distance they could not see the connecting rods that held the assembly together

"You've got three hours " Howard told them "The boosfer-tank linkages that hold it to the orbiter are built to come apart and reattach to the other tanks , '

Yeah, yeah we know." Colt said impatiently

Kinsman was thinking, *This shouldn't take more than an hour Why give us three?*

' Working in zero-g on a task like this ain't easy,' Howard said as if in answer to Kinsman's unspoken question "It's different from the water tank You'll be floating free—no resistance at all Every move you make will make you *keep on* moving until you make a countermove to cancel the motion."

"We learned all that in training," Colt insisted "And how we shouldn'f overheaf ourselves inside the suits

"Yeah sure you did Pardon me I should've remembered you guys know everything already ' Howard s voice was acid again 'All right, you're on your own Just don t panic if anything goes wrong

Almost an hour later as they were attaching the empty propellant tank to the six others, Colf asked, "How many times we practice this stunt in training?

"This particular business?

'Naw just taking pieces apart and reassembling them "

Kinsman looked up from the bolt-tightening job he was doing Colt was floating some forty meters away, up at the nose end of the fat propellant tank He looked tiny next to the huge stack of tanks gleaming brightly in the strong sunlight But his voice in Kinsman's earphones sounded as if he was inside the helmet with him

'Hell," Kinsman answered "we did so much of this monkey work I thought they were training us to open a garage "

'Yeah That's what I was thinking Then why was Howard so shaky about us doing this? You havin' any troubles?"

Kinsman shrugged inside his suit, and the motion made him drift slighfly away from the struf he was working on He reached out and grabbed it to steady himself

"I've spun myself around a couple times" he admitted "It gets a little confusing with no up or down Takes some getting used to"

Colt's answer was a soft grunt

"The suit heats up too " Kinsman went on "I've had fo stop and let it cool down a couple times "

"Yeah Me too But no trouble "

"Maybe Howard's worried about us being so far from the ship without tethers "

"Maybe ' But Colt didn't sound convinced

"How s your end going? Kinsman asked "I'm almost finished here '

"I oughtta be done in another ten minutes Three hours! This damned job's a piece of cake if ever *Holy shit!"*

Kinsman s whole body jerked at fhe urgency in Colt's voice "What? What is it?

"Lookit the shuttle!"

Turning so rapidly that he bounced his shoulder into the tank Kinsman peered out toward the spacecraft some seventy-five meters away from them

They ve closed the payload bay doors Why the hell would they do that?"

Colt jetted down the length of the tank stopping himself as neatly as an ice skater with a countering puff of cold gas from the thruster gun Kinsman reached out and touched his arm

"What the hell are they doing? he asked, bewildered

Colt said "Whatever it is, I don'f like it "

Suddenly a cloud of white gas jetted from fhe shuttle s nose The spacecraft dipped down and away from them Anofher soundless gasp from the reaction jets back near the tail and the shuttle slewed sideways

"What the hell they doin'?' Colt shouted

The shuttle was sliding away from them scuttling crabwise farther from the propellant tanks where they were stranded

"They got trouble! Somethin's wrong

Kinsman punched the stud on his wrist keyboard for the flight deck's radio frequency

"Kinsman to flight deck What's wrong? Why are you maneuvering?"

No answer The shuttle was dwindling away from them rapidly now

'Jesus Christ!' Colt yelled "They're gonna leave us here! '

"Captain Howard!" Kinsman said into his helmet mike trying to keep the tremble out of his voice "Major Podolski Major Pierce come in! This is Kinsman Colt and I are still outside the spacecraft! Answer please!

Nothing buf the crackling hum of the radio's carrier wave

'Those sons of bitches are stranding us!"

Kinsman watched the shuttle getting smaller and smaller It seemed to be hurtling madly away from them although the rational part of his mind told him that the spacecraft was only drifting if hadn't fired its main engines at all But the difference in relative velocities between the tankage assembly and the shuftle was enough to make the two fly apart from each other

Colt was moving Kinsman saw that he was aiming his thruster gun

Grabbing Colt's arm to stop him Kinsman snapped "No!" Then he realized that his suit radio was still tuned to the flight deck's frequency

Banging the stud on his wrist Kinsman

said, "Don't panic. Remember? That's what Howard warned us about."

"We gotta get back to the shuttle, man! We can't hang here!"

'You'll never reach the shuttle with the maneuvering gun,' Kinsman said. 'Not enough range.'

'But something's gone wrong...'

Kinsman looked out toward the dwindling speck that was the shuttle. It was hard to see now against the glaring white of the earth. They were passing over the vast cloud-covered expanse of Antarctica. With a shudder, Kinsman felt the cold seeping into him.

"Listen. Maybe nothing's gone wrong. Maybe this is their idea of a joke."

'A joke?'

"Maybe that's what Howard was trying to tell us."

"That's crazy."

"No. They've been sticking it to us all through the mission, haven't they? Pierce is a snotty bastard, and this looks like something he might dream up."

"You don't joke around with lives, man!"

"We're safe enough. We've got four hours' worth of air. As long as we don't panic, we'll be okay. That's what Howard was trying to tell us."

"But why the hell would they do something like this?" Colt's voice sounded calmer, as if he wanted to believe Kinsman, as if he needed to believe.

Your paranoia's deserted you just when you need it most, Kinsman thought. He answered, "How many times have they called us hotshots, the Golddust Twins? We're the top two men on the list. They just want to rub our noses in the dirt a little, just like the upperclassmen used to do at the academy."

'You think so?'

It's either that or we're dead. Kinsman glanced at the digital watch set into his wrist keyboard. "They allowed three hours for our task. They'll be back before that time is up. Less than two hours."

"And if they're not?"

'Then we can panic.'

'Lotta good it'll do then.'

"Won't do much good for us now either. We're stranded here until they come back for us."

"Bastards," Colt muttered. Now he was convinced.

With a sudden grin, Kinsman said, "Yeah, but maybe we can turn the tables on them."

'How?'

'Follow me, my man.'

Without using his thruster gun, Kinsman clambered up the side of 'their' propellant tank and then drifted slowly into the nest created by the six other tanks.

Like a pair of skin divers floating in the midst of a pod of whales, Colt and Kinsman hung in emptiness, surrounded by the big, curving, hollow tanks.

"Now when they come back, they won't be able to see us on radar," Kinsman explained. "And the tanks ought to block our suit-to-suit chatter. So they won't hear us, either. That should throw a scare into them."

"They'll think we panicked and jetted away."

'Right.'

"Maybe that's what they want."

"Maybe. But think of the explaining they'd have to do back at Vandenberg if they lost the two of us. Four officers' careers down the drain."

Colt giggled. 'Almost worth dyin' for.'

"We'll let them know we're here," Kinsman said, "after they've worked up enough of a sweat. I'm not dying for anyone's joke, not even my own."

They waited, while the immense panorama of the earth flowed beneath them and the stern stars watched silently. They waited and they talked.

"I thought she split because we were down in Houston and Huntsville and she couldn't take it," Colt was saying. "She was white, you know, and the pressure was on her a lot more than me."

'I didn't think Houston was that prejudiced. And Huntsville struck me as being pretty cosmopolitan.'

"Yeah? Try it with my color, man. Try buying some flesh-colored Band-Aids if you wanna see how cosmopolitan everybody is."

'Guess I really don't know much about it,' Kinsman admitted. 'Must've been pretty rough on you.'

'Yeah, but now that I think back on it, we were having our troubles in Colorado, too. I'm not an easy man to live with.'

'Who the hell is?'

Colt chuckled. 'You are, man. You're supercool. Never saw anybody so much in charge of himself. Like a big bucket of ice water.'

Ice water? Me? "You're mistaking slow reflexes for self-control."

'Yeah, I bet. Is it true you're a Quaker?'

"Used to be," he said automatically, trying to shut out the image of his father. "When I was a kid." *Change the subject!* "I was when that damned shuttle started moving away from us. A real Quaker."

With a laugh, Colt asked, 'How come you're not married? Good looking, rich...'

"Too busy having fun. Flying, training for this. I've got no time for marriage. Besides, I like girls too much to marry one of them."

"You wanna get laid, but you don't wanna get screwed.'

'Something like that. Like you said, there's lots of chicks in the world.'

'Yeah. Can't concentrate on a career and a marriage at the same time. Leastways, I can't.'

"Not if you want to be really good at either one," Kinsman agreed. *Oh, we are being so wise. And not looking at our watches. Cool, man. Supercool.* But out beyond the curving bulk of the propellant tanks the sky was empty except for the solemn stars.

They talked, so that the sound of their voices could steady their nerves, each of them staying calm and brave in the presence of the other.

Kinsman's mind drifted as he hung sus-

pended in space talking and listening with only the frontmost reflexive part of his mind He watched the earth sliding by like some huge diorama and his thoughts wandered back to Diane to the first night he had met her, to that first lovemaking in the misty, dreaming light of earliest dawn back in her room in Berkeley

He remembered coming out of the tiny bathroom later that morning, to see that she had set up toast and a jar of Smucker's grape jelly on the table by the window The teakettle was on the two-burner stove, and a pair of chipped mugs and a jar of instant coffee stood alongside

They sat facing each other washing down the crunchy toast with hot bitter coffee Diane watched the people moving along the street below them Kinsman stared at the clean bright sky

"How long can you stay?" she asked

"I've got I leave tonight"

"Oh"

"Got to report back to the Academy tomorrow morning"

"You have to"

He nodded

"I was going to let you stay here if you wanted to quit the Air Force"

He started to answer but his mouth was suddenly dry He thought of the Academy The cold gray mountains and ranks of uniforms marching mechanically across the frozen parade ground The starkly functional classrooms, the remorselessly efficient architecture devoid of all individual expression

And he thought of his father cold implacable Was it pride and anger that moved him, or was it fear?

Then he turned back, looked past the woman across the table from him and saw the sky once again A pale ghost of a moon was grinning lopsidedly at him

"I can't stay with you" he said quietly, finally

That was probably the biggest mistake of your life he said to himself

Frank Colt's sharp-edged voice brought him back to reality to the world he had chosen for himself

"I don't just wanna be good Colt was saying "I got to be the best I got to show these honkies that a black man is better than they are"

"You're not going to win many friends that way"

"Don't give a shit I'm gonna be a general someday Then you'll see how many friends I get"

Kinsman shook his head chuckling "A general Jeez, you've sure got some long-range plans in your head"

"Damn right! My brother, he's all hot and fired up to be a revolutionary Goin' around the world looking for wars to fight against colonialists and injustice Wanted me to join the underground here in the States and fight for justice against the Man"

"Why doesn't he stay in the States?" Kinsman asked

"The FBI damn near grabbed him a year or so back, last time he came home"

"What for?"

"Hit a bank ... to raise money for the People's Liberation Army"

"He's one of those?"

"Not anymore There ain't no PLA anymore Most of 'em are dead, the rest scattered I watched my brother playin' cops and robbers Didn't look like much fun to me So I decided I ain't gonna fight the Man I'm gonna *be* the Man"

"If you can't beat 'em"

"Looks like I'm joinin' 'em, yeah," Colt said, with real passion building in his voice "But I'm just workin' my way up the ladder to get to the top Then *I'll* start givin' the orders And there are others like me, too We're gonna have a black president one of these days you know"

"And you'll be his chief of staff."

"Could be"

"Where does that leave us?"

A small sharp beeping sound shrilled in Kinsman's earphones *Emergency signal!* Automatically both he and Colt switched to the shuttle's flight deck frequency

"Kinsman! Colt! Can you hear me? This is Major Jakes Do you read me?

The major's voice sounded distant, distorted by ragged static, and very concerned

Kinsman held up a hand to keep Colt silent Then switching to their suit-to-suit frequency, he whispered "They can't see us in here among the tanks And they haven't picked up our suit-to-suit talk The tanks are blocking it"

"We're getting their freak scattered off the tanks?" It was a rhetorical question

"Kinsman! Colt! Do you read me? This is Major Jakes"

Their two helmeted heads were close enough for Kinsman to see the grin glittering on Colt's dark face

"Let 'em eat shit for a coupla minutes, huh?"

"Right"

The shuttle pulled into view and seemed to hover about a hundred meters away from the tanks Switching back to the flight deck's frequency, the two lieutenants heard "Pierce goddammit if those two kids have been lost I'll put you up for a murder charge."

"Now you were in on it, too, Harry"

Howard's voice cut in "I'm suited up Going out the airlock"

"Should we get one of the trainees out to help search for them?" Pierce's voice

"You've got two of them missing now" Jakes snarled "Isn't that enough? How about *you* getting your ass outside to help?"

"Me? But I'm"

"I think it would be a good idea," said a new voice, with such weighty authority that Kinsman knew it had to be the mission commander, Major Podolski Among the three majors he was the longest in Air Force service and therefore as senior as God

"Eh, yes, sir" Pierce answered quickly

"And you, too, Jakes You were all in on

this and it hasn't turned out very funny."

Colt and Kinsman, holding on to one of the struts that connected the empty tanks, could barely suppress their laughter as they watched the shuttle's cargo doors swing slowly open and three spacesuited figures emerge.

"Maybe we oughtta play dead," Colt whispered.

"No. Enough is too much. Let's go out now and greet our rescuers."

They worked their way clear of the tanks and drifted into the open.

"There they are!" The voice sounded so jubilant in Kinsman's earphones that he couldn't tell who said it.

"Are you all right?"

"Is everything ...?"

"We're fine, sir," Kinsman said calmly. "But we were beginning to wonder if the spacecraft malfunctioned."

Dead silence for several moments.

"Uh, no ..." Jakes said as he jetted up to Colt and Kinsman. "We ... uh, well, we sort of played a little prank on you two fellas."

"Nothing personal," Pierce added.

Sure, Kinsman thought. *Nothing personal in getting bitten by a snake, either.*

They were great buddies now as they jetted back to the shuttle. Kinsman played it straight, keeping himself very formal and correct. Colt followed Kinsman's lead.

If we were a couple of hysterical, gibbering, scared tenderfeet, they'd be laughing their heads off at us. But now the shaft has turned.

Once through the airlock and into the passenger compartment, Colt and Kinsman were grabbed by the four trainees. Chattering, laughing with them, they helped the two lieutenants out of their helmets and suits. Pierce, Jakes, and Howard unsuited without help.

Finally Kinsman turned to Major Pierce and said tightlipped, "Sir, I must make a report to the commanding officer."

"Podolski knows all about ..."

Looking Pierce in the eye, Kinsman said, "I don't mean Major Podolski, sir. I mean Colonel Murdock. Or, if necessary, the judge advocate general."

Everything stopped. Jill Meyers, who had somehow wound up with Kinsman's helmet, let it slip from her fingers. It simply hung there in midair as she watched, wide-eyed and open-mouthed. The only sound in the compartment was the faint hum of electrical equipment.

"The ... judge advocate general?" Pierce looked slightly green.

"Yes, sir. Or I could telephone my uncle, the senior senator from Pennsylvania."

Now even the trainees looked scared.

"Now see here, Kinsman," Jakes started.

Turning to face the major, close enough to smell the fear on him, Kinsman said, "This may have seemed like a joke to you, sir, but it has the look of racial discrimination about it. And it was a damned dangerous stunt. *And* a waste of the taxpayers' money, too."

"You can't ..." Pierce somehow lost his voice as Kinsman turned back toward him.

"The first thing I must do is see Major Podolski," Kinsman said evenly. "He's involved in this, too."

With a resigned shrug, Jakes pointed toward the ladder.

Kinsman glanced at Colt, and the two of them glided over to the ladder and swam up to the flight deck, leaving absolute silence behind them.

Major Podolski was a big, florid-faced man with an old-style RAF mustache. His bulk barely fitted into the commander's left-hand seat. He was half-turned in it, one heavy arm draped across the seat's back, as Kinsman rose through the hatch.

"I've been listening to what you had to say down there, Lieutenant, and if you think ..."

But Kinsman put a finger to his lips. Podolski frowned.

Sitting lightly on the payload specialist's chair behind the commander, Kinsman let himself grin.

"Sir," he whispered, "I thought one good joke deserved another. My uncle was voted out of the Senate years ago."

He could see a struggle of emotions play across Podolski's face. Finally a curious smile won out. "I see ... you want them to stew in their own juices, eh?"

Glancing up at Colt, Kinsman answered, "Not exactly, sir. I want reparations."

"Repa—What're you talking about, Mister?"

"This is the first time Frank and I have been allowed up on the flight deck."

"So?"

"So we want to sit up here while you fly her back through reentry and landing."

Podolski looked as if he had just swallowed a lemon, whole. "Oh, you do? And maybe you want to take over the controls, too."

Colt bobbed his head vigorously. "Yes *sir!*"

"Don't make me laugh."

"Sir ... I meant it about the judge advocate general. And I have another uncle ..."

"Never mind!" Podolski snapped. "You can sit up here during reentry and landing. And that's all! You sit and watch and be quiet and forget this whole stupid incident. That's an order!"

"That's all we want, sir," Kinsman said. He turned toward Colt, who was beaming.

"You guys'll go far in the Air Force," Podolski grumbled. "A pair of smart asses with the guts of burglars. Just what the fuck this outfit needs." But there was a trace of a grin flitting around his mustache.

"Glad you think so, sir," said Kinsman.

"Okay ... we're due to break orbit in two hours. You guys might as well sit up here through the whole routine and watch how it's done."

"Thank you, sir."

The major's expression sobered. "Only who's going to tell Pierce and Howard that they've got to sit with the trainees?"

"Oh, I will," Colt said, with the biggest smile of all. "I'll be glad to!" ∞

GRAVESIDE WATCH

CONTINUED FROM PAGE 72

tive century. Unfortunately the time traveler himself has become delirious, and the friend is worried about him having a mental breakdown, going crazy, becoming most dangerous. So he tries to get a message to the future."

Frank pressed the palm of one hand against the knuckles of the other. Three knuckles discharged, each at a different pitch. There was a dangerous logic to Sagehorn's theory. In a weaker moment, Frank might have embraced that logic. Maybe. He glanced up at the stars. One of them seemed brighter than the others, but he knew that the light he was seeing had left that star thousands of years ago. For all he knew, the star might not be there anymore. Sometimes it was better not knowing.

"Well, even if I believed in your theory, I couldn't get your box in that capsule anyway. The contents are already laid in there like a three-dimensional puzzle. Nothing more will fit."

"Smuggle it in. Remove something and put my box in its place."

"Remove something—for a box and some half-baked theory?"

"I'm a time-capsule seeder. Been seeding time caps for the past twenty years. My theory is hardly... half-baked."

Frank was disappointed, although he didn't know why. "You mean this isn't your first?"

"Ah, no, son. I'm afraid it isn't." He frowned, but then his face brightened. "But yours shows the most promise for survival. Prospects are as good as those for the capsule the Northingale Corporation buried back in Sixty-three. However," he looked off to the side for a moment, "apparently it will never be found."

"You've been testing this theory for the past twenty years, and it's never worked?"

"Time caps are tricky. Some will be dug up much too soon. Say one or two hundred years at the most. Well before the age of time travel."

Frank felt sorry for the crazy old guy. Twenty years! He wondered how many he had "seeded" and then chuckled at the thought of future scientists scratching their collective heads. "I just wish I could be around when they open up a capsule and find one of your scrolls."

"Oh, they'll probably start popping them open in the next century. Course, they might think the first one amusing, as you do."

Frank raised his eyebrows in a polite protest.

"But when they discover that the second, third, fourth—" He stopped and extended his arm to indicate a whole crop of capsules. "When they see that almost every long-range time capsule buried in the twentieth century has the same message in it, they may find it most disquieting."

"And you're counting on that, aren't you?"

Sagehorn raised his shoulders and made his neck disappear. "Sure. That's the kind of mystery that legends and myths are spun from. If my time caps don't survive hundreds of years, maybe a fascinating legend or two may."

This was too well thought out for Frank to simply dismiss it. The plan had some depth to it. Suddenly Frank realized that he was in the presence of an imagination as wild as his. A fellow sufferer! Was *this* the old man that he would become in thirty years? A hopeless dreamer with a curious obsession?

Instinctively, he picked up the box and carefully tried to open it, as if it would allow him a glimpse into the future.

"It's sealed," said Sagehorn.

"Why?"

"An extra precaution. The scroll is preserved in a vacuum."

"Oh?"

Frank turned the box over in his hands a couple of times. It had an oily film on it, like a new pair of garden shears. He could even smell the greasy freshness of the metal. He set the box down.

"Just curious about what you had written on the scroll."

"Time and place is the essential part. But most of the scroll is simply a carefully written portrait of a delirious time traveler

"Of course I'm listening to you, Harriet. You said you were a Martian."

stranded in this century However, the gist of the matter is that I promise—in the scroll—to bring my time traveler friend to a specific location at a certain date and time to await a rescue attempt Exact time and place mind you Therefore, when they receive this message, some time travelers will be dispatched to the Raven Hill Tavern "

"The tavern?"

'That's where I'll be at exactly five PM, a week from Friday I've already described my physical features in the scroll So if my plan works then some actual time travelers will contact me there "

"And you'll prove their existence."

"Precisely"

Frank raised the cup to his lips and eyed Sagehorn over the rim So far he had managed to confine his observations to just the theory The theory held up, but what about the old man himself? He hesitated when it came to Sagehorn Somehow he could sense a magic in his face Or his voice Or was it just his own imagination? Well, sometimes it was better not to know how the trick was done

But the questions kept coming Who was this old man? Where did he come from? Was he crazy or brilliant? There were too many questions, and despite the man's appearance, Frank knew that Sagehorn had the razor-sharp steel-trap mind that could tear the meat off a convoluted question He paused and then held out a bony "Why?"

'Why what?"

"Well why have you spent twenty years—"

Suddenly it hit him What the whole conversation had been leading up to but never quite touching The thought burst into focus stunning him for just a moment Was reality finally outstripping his imagination? Had he been overlooking his basic anthropology?

He had to know for sure

'Okay, Mr Sagehorn' he said, finding his voice again "I'll get it in the capsule"

Sagehorn smiled reached down to pet his dog and then raised his cup to Frank

'But I just had an interesting thought" said Frank, recovering somewhat and joining in the toast He took a sip of his coffee and then set it down next to the fire 'Don't know why I didn't think of it before"

'What's that?' asked Sagehorn

With hands clasped behind his head, Frank leaned back against his camping gear and gazed up at the glittering stars They glistened with the polish of time A few even winked at him

'Well, Mr Sagehorn, suppose there *really was* a time traveler stuck in this century And suppose that a time capsule was, indeed the only way he could get a message to the future Now, the question is," he glanced back at Sagehorn, "How would this time traveler go about convincing someone to smuggle his message into the capsule?"

Sagehorn shrugged, but he couldn't hide the twinkle in his eye 'Oh, he'd probably think of something,' he said with a wink ∞

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removed from us in brainpower as we are from ape-men.

Another type of branching is possible. On Earth both man and bat evolved from a shrewlike tree-climbing mammal. If the bat dominated evolution on another planet, its large-brained descendants could do most of the things we can and would be able to fly as well.

Then again, an animal need not be some kind of mammal to walk upright. Some dinosaurs walked on their hind legs and evolved squirrellike hands. If reptiles became a planet's dominant life form, there is no reason why they could not develop superior brains. Unless they also acquired full-fledged hands, however, it might be difficult for them to create a technological civilization.

The octopus is an intelligent and emotional creature. It turns white when frightened, red when angry. It could well be a good candidate for life's crowning achievement on another world, despite the earthly model's walnut-sized brain. This would be especially likely if it came to live on land. "If an octopus can evolve from a slug," Dr. Berrill says, "then all kinds of things are possible. Any form of life could conceivably become intelligent under favorable conditions."

Not even insects can be excluded. On Earth two factors keep their size down. Their skeletons are on the outside, and because they have no lungs, they must pump oxygen to their bodily tissues through air tubes. Doubling an insect's size under these conditions would cube the mass of its tissues, making them too heavy for the chitinous exoskeleton to support and requiring more oxygen than the air tubes could supply.

Yet there is no reason why an insectlike creature on another planet could not evolve a good brain. With appendages designed to manipulate things easily, they could build more complex structures than terrestrial insects do, and they could evolve much more complex societies.

At some stage in their evolution, it would be possible for us to talk with such otherworldly creatures. Most would probably have evolved vocal cords or some equivalent, and developed some form of language. If we could learn to talk to the dolphins, we would be well prepared for extraterrestrial dialogues.

We will probably have to talk with our cosmic cousins in person. Dr. Robert Jastrow, director of NASA's Goddard Institute for Space Sciences and author of the recent best-seller *God and the Astronomers*, explains: "The four billion years during which life has been evolving along the carbon chain in its present form are themselves a very small fraction of the age of other planets and other stars. Most of the stars are in round numbers three or four billion years younger or older than we. Younger planets, of course, are nothing, and the older ones—where are they? A billion years ago man was a worm in his ancestry. A billion years from now we will have evolved as far from our present form as we have from a worm."

Only a tiny fraction of the civilizations on other planets will communicate as we do. Younger ones will not yet have developed technology. Older ones will have relegated radio to their attics millions of years ago. Communication by radio will probably remain just a dream.

What might we learn from such creatures? Not the usual pap that people speculate about. Nontechnological societies will not tell us how to cure cancer or to control thermonuclear arms. We may learn instead to our shame, what we should have learned from our own not always humane history long before we started on the road to the stars—that the survival of an intelligent species requires not higher technology but greater humanity. To have that demonstrated to us by nonhuman creatures could be the ultimate insult to our human vanity.

But there could also be a positive lesson in the discovery that man is alone in the universe, a unique, unrepeatable being. The knowledge that intelligent life is found only on one fragile planet could drive some sense into the heads of politicians as they tinker with their lethal arsenals.

Beyond physical life forms there may be other beings billions of years ahead of us. "It's difficult to imagine the unimaginable," Dr. Berrill says. Yet able people have tried.

"I don't think life such as ours with a lot of water and the carbon chain is more than an ephemeral stage," Dr. Jastrow asserts. "Knowing the length of the universe's existence and the short time the earth has existed, I don't think that life in the cosmos, more than a fraction of it, is some distorted replica of our chemistry. I think it's either disembodied life of mind entirely or in the silicon form—not the sand-eating monsters, but what we call the computer. I would put my money on the silicon memory bank as an immortal form of life and on the disembodied form as the ultimate."

"My belief is that every planet with suitable water and temperature goes through four or five billion years of carbon evolution. As Dr. Ponnamperuma says, the ingredients are abundant, the reactions go well, and the Urey-Miller experiment [which simulated conditions on Earth billions of years ago] showed that everything starts off nicely."

"And then I think after four or five billion years life passes on to a less vulnerable and more expandable framework for housing its intelligence. And it leaves the carbon-based life behind it. So there are creatures like us around, but they must be very thinly scattered and not the majority. We humans are a very small slice of time."

It's a monument to the inventor of the throwaway

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light while hovering and a bright light when accelerating. There was a large, red light in front, two retractable sidelights, like clusters of cubes mounted on curved tubing, six dangling cables with frayed ends, and two hooklike arms. No rivets, bolts, screws, seams, or patterns could be seen.

Pecha described the UFO's movements, giving his estimates of distance, as it receded from his home. (Experienced UFO investigators realize that the only things a witness can really perceive are direction and angular size and that distance is a subjective judgment in such a case.) The hooklike arms partially retracted; the sidelights swung out, and a powerful searchlight projected downward but cut off in midair. Suddenly the UFO swooped off to some foothills about 32 kilometers to the west, reaching them in only a few seconds.

Pecha had also seen two other UFOs in the distance hovering over some 500,000-volt power lines. From an interplay of blue beams and an arc of light, Pecha concluded that the UFOs 'might have been zapping power' which he thought would account for his electrical failure. Meanwhile the large UFO abruptly leaped back across the 32 kilometers, looming again near Pecha's property. The two smaller UFOs then vanished, and the electricity in Pecha's home came back on.

At this point Pecha had seen enough. "I thought we were going to get destroyed," he recalled. In panic, he roused his family, loaded them into his pickup, and drove off at 150 kilometers an hour, and the object continued to follow him. He stopped at a friend's home a short distance away and pounded on the door. His friends came out and also saw a "domed saucer with an illuminated underside," larger than the full moon, which sped off toward the west and then southward, disappearing suddenly.

Three other independent witnesses soon appeared, each calling the Colusa County sheriff to report an extremely bright light whose movements closely matched those of the UFO Pecha had observed. Pecha remained shaken. "It was a bad nightmare, and I don't want to go through that again, never!" he declared. But neighbors repeatedly vouched for his honesty and calm.

So something very odd seems to have happened. In analyzing the case, CUFOS checked out nearby radar sites, helicopter services, and the U.S. Weather Bureau. Nothing had been tracked by radar at Sacramento or Oakland or Beale Air Force Base, and there had been no illuminated balloons in the area. CUFOS determined that there were four possible solutions and estimated the probabilities of each: hoax, 1 percent; misperceived aircraft, 4 percent; exaggerated fantasy, 35 percent; and genuine UFO, 60 percent. But the term *genuine UFO* is not an explanation, merely an admission that no explanation has been found.

Experienced UFO investigators know that Pecha's description of the apparition as zooming back and forth and then following his pickup truck is common when an honest observer misjudges the range to a large, distant light—a very convincing illusion once some unconscious and subtle wrong assumptions take root in the witness's mind. The jump to the foothills 32 kilometers away would have required an acceleration in excess of four million times the force of gravity if Pecha's range estimates were accurate. And the object Pecha's neighbors described was at least 30 times smaller than the one Pecha told of—unless the witnesses were making wrong assumptions about the distance. Unfortunately this happens all too often.

The dangling tentacles and the UFO's overall measurements are strikingly reminiscent of high-altitude rocket plumes. The inhabitants of Petrozavodsk, in the Soviet Union, were terrified by a "glowing jellyfish UFO" late in 1977. The apparition was actually caused by a Soviet space shot.

> *"In panic, Pecha packed his family into the pickup and sped off at 150 kilometers an hour. "I thought we were going to get destroyed," the normally calm mechanic recalls."*

The direction taken by Pecha's UFO seems to point toward the rocket range at Vandenberg Air Force Base several hundred kilometers to the south and west. And indeed there had been a rocket launch at the appropriate time, but it was made one day later. Neither Pecha nor the Air Force information officer who told of the rocket had confused the dates, because both events occurred near midnight. The rocket hypothesis, too, thus proved to be a dead end.

Pecha also mentioned feeling an immense charge of static electricity which led to a suggestion that the mysterious phenomenon of ball lightning could have been involved. Some damage to vegetation was found near Pecha's home, but a check for radioactivity in the surrounding area found nothing abnormal.

One puzzle involves Pecha's description of the two small UFOs 'zapping' the distant power lines. Pecha clearly believed, and many investigators would have assumed without question, that this activity caused his power failure. He told his story accordingly, and the belief may have colored his raw perceptions. CUFOS investigator Hendry, who worked with reports from Paul Cerny, a CUFOS representative, and with Mutual UFO Network members Robert Neville and Lois Williams, found that the power lines Pecha cited had nothing to do with his own electrical supply. Though Colusa County was blacked out by an overloaded transformer eight kilometers west of Pecha's mobile home, the power line he mentioned led to a power system, named the Central Valley Project, maintained by the federal government. It had experienced no power problems at all on the night of September 10.

Although odd, this discovery does not suggest that Pecha was deliberately fabricating his story. But it does hint that his conclusions about what he had seen probably affected his memories. This happens all too frequently, much to the sorrow of serious UFO investigators whose work the effect obstructs.

The major problem in explaining many UFOs seen by honest, clearheaded witnesses is the hundreds of ways in which people can be fooled by their own senses. The result can be as fantastic as any sighting of a "true UFO."

A good example comes from the files maintained by CUFOS. On April 29, 1978, ten people called the Aurora, Illinois, police department to report a "saucer" flying at treetop heights. The object hovered motionless, then shot off eastward "in the blink of an eye."

The case, according to Hendry's final report, was "rich in elements that are traditionally supposed to underwrite the value of a genuine sighting." Yet Hendry proved that the UFO was really a 315-bulb advertising sign slung under a small plane.

The plane became a UFO, Hendry says, because of "the pervasive emotional climate that appears to be surrounding the entire UFO subject, one that succeeds in distorting even the most commonplace sightings into exaggerated miracles." This trap is one that UFO investigators for the most part fail to avoid when faced with the task of evaluating earnest, honest UFO reports.

Whatever the problems with Pecha's testimony, he had the courage to talk about his encounter—a courage all too rare. Investigators suspect that the risk of ridicule by friends and neighbors has silenced the majority of UFO witnesses and has robbed serious researchers of the data they need to explain many cases or to establish their inexplicability.

What actually happened, then, is unclear. Granting that physical evidence is inconclusive, a number of independent and presumably honest witnesses have testified to the event. Though their interpretations of the size, distance, and motivations of what they saw served only to confuse their narratives, their descriptions of angular size and movement might be valuable. There was a UFO over Colusa County that night. The dispute still rages over what, if anything, it proved. ∞

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SARASWATI

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exam in Philadelphia a few years ago was defeated on the same grounds. Then Science's alumni organization, one of the most dedicated in the 50 states, struck back. A bill was lobbied through the New York State legislature that required that the entrance exam be retained as long as the school promised to search out and admit the 'talented deprived' (read: minorities). Bronx Science agreed, and that's one reason why Arani Bose was at Science. (At present 10 percent of the school's 3,000-plus students are Asian, 11 percent are Hispanic, 15 percent are black, and Jews constitute most of the remainder.)

The resulting melting pot at Science is as good a reason as any why Science graduates will have their shot at planning the future and running the world. It's also a reason that partially explains why Arani's current girl friend, Lynn King, is Chinese and why his best friend—who was accepted by MIT, Yale, and Johns Hopkins but opted for a fourth school instead—is Manny Rosen. With the exception of Lynn, Arani explains, all his best friends are Jews.

Kiss the book and pray to Saraswati.

Arani Bose will go to Stanford this fall, his first choice over several other glamour universities. He will probably concentrate on immunology instead of on his standby, the chemistry of memory and learning, "unless I find the right faculty person in that field." Sciencers are used to exercising a certain selectivity.

Arani's eyes are almond-shaped and set in a head that is compressed, with a face that is almost as wide as it is long and a head that runs more than the average length from front to back. He carries this around gracefully on broad shoulders and short legs. He is an only child, very close to his mother and father and is a breathing example of that ultimate goal of Eastern philosophy: detachment with empathy.' In his research projects, he is meticulous and attentive to detail. Arani is certain to be a cautious and above-average academic researcher. He strikes you as a possible future prime minister of India if intelligence is any indication of political bent.

The name *Arani* is Bengali for "flint stones,' used to start the holy fires of the Hindu religion. In matters of Hindu culture, Arani displays the drive of a convert. He was brought to America at the age of five. Later he returned to Calcutta for two years and he hopes to visit Calcutta again soon. Though in his short life he has been exposed to little more than American schools and the counterparts of Manny Rosen, more and more a sitar buzzes in his brain. Tagore sings, and Watson, Crick, and *The Worm-Runners Digest* provide Muzak.

"When I come home from Science and enter that front door," Arani explains, "I enter another world. It's totally Bengali. Very stable, comfortable, and warm—a true relief from the pressures and tensions of Science. Although we speak only Bengali at home, the house itself is not self-consciously Hindu. It's your average nice, white two-story home in a good part of the Bronx—my parents moved here from Queens after I was accepted at Science—with a small backyard and Daku, my German shepherd, in it. The only indications that we are Indian are a small Hindu mask on the living-room wall, a Buddha in the dining room, my father's sitar, a little table with a painting of the goddess Lakshmi [the goddess of wealth] and photographs of two devotees of Kali [the goddess of destruction]. On the wall, of course, is Saraswati. My mother prays here every day without fail."

Arani's mother, Bani, garbed in a sari and with a red spot on her forehead—she and her husband are members of the Kayastha caste, the Hindu pigeonhole for the professional and business classes—reveals that Arani, surprisingly, is really not all that bookish. In a high, birdlike voice, she tells how he kicks a fierce soccer ball, plays tennis, and likes to go to museums and serious movies (he loved Woody Allen's *Manhattan*) and watch TV (*Lou Grant* and *The Paper Chase* are, predictably, his favorites). For light reading, he skims *Scientific American*, *Modern Photography*, the journal of the junior branch of the New York Academy of Sciences, and *Omni*.

"Class standings are meaningless at Bronx Science. In another high school an average of 90 would put you at the top of the class. Here, it would make you 425th out of 850."

Lynn King, who is not very interested in science and would rather study Chinese, is another smiling diversion from the pressures and tensions. Together the two are mad about New York's welter of ethnic restaurants. 'On our first date we ate Indian, on the second, Chinese, and by the third we compromised on French," Arani declared.

The Bose basement holds yet another part of Arani's world. For four years he has worked there with petri dishes, wires, batteries, goldfish, and planaria worms to find some previously unknown facts of nature. His findings have made him a frequent winner of New York area science fairs and have propelled him into Westinghouse's 1979 top 40.

Arani has become one of the few researchers anywhere who still work on a biological mystery that was very hot among scientists in the 1960s but declined as the scientific community began to cry misfire or fraud: the brain chemistry of memory and learning.

Remember the researchers who played with planaria worms? Ground up right-turning planaria, fed the mush to left-turning planaria, and then announced that their left-turners had become right-turners? Remember how this meant that learning could be passed on chemically, that maybe there was a "smart pill" in our future? Well, very few scientists were able to reproduce the results. Some believed the experiments were so funny that they founded one of history's very few science-humor journals: *The Worm-Runners Digest*.

Even Arani's eighth-grade biology teacher had to suppress a giggle when he told the class about the planaria-memory debacle. Arani, however, was not amused. He was fascinated and read all the pertinent scientific papers. When he was selected for Science's highly impressive 'Creativity in Biology" program—a program the U.S. Office of the Gifted and Talented (read: the Office of Education) has selected as a national model for other high schools to follow—he resolved to pursue the planaria question further than anyone else in the world.

During the early part of his research, Arani was able to duplicate the original planaria work perfectly yet found it subject to criticism when he entered it in a science fair. He then switched to goldfish but eventually returned to planaria since a similar organism would yield clearer results. Finally, the young scientist hit upon the idea that memory and learning were related to increased synthesis of protein by the brain and began a long search—"I bothered a lot of people at Einstein Medical College and the New York University Medical Center'—for a drug that would effect increased protein synthesis. He finally hit upon "Poly-I:C.' When the drug was fed to his planaria, Arani noticed a striking increase in their short-term learning ability, but it disappeared soon afterward.

"Poly-I:C is just a short-term memory booster, something like amphetamines," Arani explains, "and I really don't know if there would be any useful human applications here. The interest of the experiments, however, is that they clearly demonstrated that an improvement of memory is related to protein synthesis."

That finding propelled him into the Westinghouse finals.

The planaria work in the basement usually ends Arani's day. Here is how it begins. He gets up at 7:00 A.M., takes Daku for a walk, sips a little juice, eats a cookie, and takes a brown-bag lunch to Science, where he arrives at 8:20 A.M. The broad plaza in front of the four-story red-and-white-brick box that is Science teems with jeaned stu-

dents, not as many smoking as in most high schools, nor as many scuffling. Readers of the New York *Daily News* seem to outnumber readers of *The New York Times*.

One's first impression is that these are rather small kids, and that is correct. Many of them have been double-promoted in the past and are younger than their same-grade counterparts elsewhere (which is one reason why Science does not have a football team). The absentee rate is unusually low, for any high school. When the doors open, walky-talkied security men look the kids over closely to be sure that no nonstudents are infiltrating. A loudspeaker sounds, making the pertinent announcements of the day, beginning with "Ladies and gentlemen . . ."

On an average Monday Arani begins his day with a highly advanced calculus class under math-department chairman Mrs. Henrietta Mazen.

"That class is as intense as a whole day of school," Arani said. "Mrs. Mazen is rigorously challenging, yet outside of class she's like your grandmother."

(Math incidentally ranks with biology as Science's academic jewel. Science students are repeatedly successful in mathematical competitions, and the mathematical journal published there is, according to one faculty member, so advanced that only professional mathematicians can understand it.)

Then Arani changes his pace with a television-production course, taught by English-department chairman Rifkin.

"This is a bit of a disappointment," said Arani, once again displaying that Science selectivity. "Many students take it to get out of senior English, and this hurts the quality of our productions. Our current project, incidentally," he said, "[was] to make an orientation film for first-year students."

After the tube session, Arani plunges into another long-term interest, physics, followed by biology, where he laments, "the teacher isn't terribly well informed about molecular biology." Gym class is next, and Arani admits, "I am not very good."

Later in the day he takes social studies. A while ago the class began to deal with Hinduism. "We've been asked to discuss the effect of Hinduism on life in India," he notes. "Now isn't that ludicrous? Hinduism *is* life in India."

During the latter part of the day he works in his beloved biology lab under the guidance of one of his favorite teachers, Mrs. Pearl Strom. She was extremely helpful, said Arani, in showing him how to write the paper on the planaria research.

"Helpful? I don't know about that," Mrs. Strom said. "I had him cut it down by two thirds."

Arani's day ends with art class, a first-year course in which he was the only senior. He doesn't say much about this activity except that he has "an extreme lack of interest in the way our instructor teaches it."

Arani digs Science. "We have a very safe and pacific atmosphere here," he said. "I've never been mugged. [Note: Arani hadn't even heard of the frightful Villa Avenue gang until I mentioned it, although it is well known to the faculty.] There is much more freedom here than at other high schools. It's more like a junior-college atmosphere than a high-school one."

Yet Science is indeed a high school, although certainly a unique one. If Arani and his fellow students had gone to PS 1000 instead, would they have been pounded into dullness by anti-intellectual peer pressure, inferior facilities, student violence, bullied teachers, confrontation-minded unions, and drugs? Would their alertness and curiosity have been turned off by a system that produces high-school graduates who cannot read? Probably. At the same time would it be fair to create a two-tiered system in which the non-entrance-exam schools would be generally dismissed as idiot factories? Certainly not. The property tax–payers of the nation, however—who are already voting with their feet for private schooling and institutions like Science—will probably increase pressure on public officials to abandon such distressing "norms" altogether.

Who really knows? In the meantime, all we can be certain of is that Arani and his peers at Science are being groomed to shape the twenty-first century for us. ◻◻

PICNIC

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standard day in the lunar month, showing where such sites might be looked for in the area around West Limb. It was a brilliant piece of applied astronomy.

That afternoon my rocket hopper was scheduled to haul a load of hung-over engineers back to Polar Solar from their monthly spree at Grimaldi, and we had to make a lot of local trips, too. I let my copilot do all the flying while I studied one of those maps. Each time we boosted out of the West Limb hopper pad, I compared the map with the territory (or is it lunitory?) round about. By quitting time, I had selected a promising rock field a short distance north of the base. It all seemed so safe and easy.

That night I cashed in on the accumulated favors that people on the base owed me. I got the next day off and a free recharge of my vacuum-suit backpack, and I borrowed two one-man vacuum-survival tents. I arranged for an airtight case packed with cold chicken, potato salad, cole slaw, some vegetables, a fresh loaf of French bread with real butter, lemonade, and two bottles of Boordy Vineyards' *vin gris*. West Limb may have been a real sty in those days, but the pigs ate and drank well.

The cafeteria manager had heard rumors. He drew me into a corner of the kitchen, looked around carefully, and leered at me.

"Suarez," he said confidentially, "what are you up to? I mean, really?"

"Porkner," I said, "a gentleman, who is entrusted—"

"No, I mean, really. No kidding. Is it—"

"You got it. It's a technical operation. Something new," I said, leering back at him.

I made my escape while he was oh-ho-ho-ing at me. It doesn't do to antagonize the cafeteria manager, or to tell him anything, either. I went to bed early that evening. Lucky for me, it was my turn in the shower.

Stacy Cramblitt was waiting for me at the hatch when I got there at ten hours. All the running around and plotting I had done had seemed a little sordid to me. I guess. But the way she looked, standing there, cool and amused, in her tailor-made fluorescent-pink pilot's vacuum suit made my conscience clear up right away.

"Everything set?" she asked.

"Not quite yet," I said, putting my load of survival tents, blankets, and the food case into the airlock. For once there wasn't anyone in the corridor near the hatch. I held her by the arms and drew her close to me.

"I'm setting your suit radio on my private channel," I said. She looked at my face as I clicked the knob on her chest module. A delicate perfume rose from her collar ring.

"You have nice eyes," she said. "Now you're blushing."

"Nonsense. After you."

We stepped into the airlock and went through the rest of the suit-checkout procedure. I locked us through to the outside. The sun was glaring in the west. The structures scattered on the surface extended inky shadows across the rutted, pockmarked ground. As we walked, Stacy's helmet swiveled. She was taking in the torn-up ground, the glinting litter of aluminum scraps and shards, the awkward tangle of antenna towers and guy wires, and the humped and ugly buildings.

"It's not very pretty," I said.

"The human race takes its mess with it everywhere it goes," she said.

"Better here than on the earth," I said. "Besides, it's not all like this. This is a little zit on the face of a whole world. We're just a short walk from the real moon, where no one has ever set foot. Give it a chance." I took hold of one of her gloved hands.

"Okay," she said, looking at me. I couldn't see her face through her mirrored sun visor, but I felt her squeeze my hand.

We must have been an odd sight as we hiked out of view over the first ridge north of the base. There were undoubtedly a hundred people peeking at us from the windows of the base buildings. I was lugging the rolled-up tents and the food case. Stacy had a blanket over each shoulder. One of the blankets was a garish plaid, the other was white with green and orange stripes and the words *FUERZAS ARMADAS DE MEXICO* printed on it.

An hour later we were crossing the vast boulder-strewn slopes of Hevelius Crater, overlooking the flat Oceanus to our right. I noted that our feet were in the shade, but the tallest boulders reflected a lot of sunlight onto the ground. We could see well enough to pick our way along, and my blackbody thermometer registered in the middle teens. The map supplied by my computer-pushing pal was proving remarkably reliable.

"You know, it's not just all gray, black, and white," Stacy said. "I can see all kinds of subtle colors. Look at that greenish streak in the rocks over there. See it?"

"I sure do. You've really got good eyes. Most people can't see these things until they've been on the moon for a year or more. Most don't care. There's a lot of beauty here. It just doesn't smack you in the eye the way it does back on Earth. God didn't make this scenery for clods. You have to have some talent and sensitivity." I was laying it on a bit thick, but it wasn't *all* crap.

Stacy was having a good time in the low gravity, bouncing around me as I went striding along. She kicked up a big cloud of dust in front of us.

"Look at that," she said. "That dust settled so quickly that I could almost hear the thump it made on the ground. I've logged a lot of hours in space, but this is the first time I've ever been on my feet like this on another world. Do you ever get used to the strangeness?"

"This nitrous oxide leak will cost the company thousands, Barnes. You're fired."

"Not really," I answered. "I never really get completely used to it. I'm always finding new things to look at." I stopped suddenly and stooped to look at the ground. "Look here."

As she bent over I pointed out a circular pattern in the dust. In the center of the circle was a tiny grain of shiny glass. Hairlike lines radiated from the center of the pattern. The lines looked as if someone had drawn them in the dust with a fine needle. The entire formation was about the size of a dime. There were also concentric arcs in the pattern I had discovered.

"What *is* it?" Stacy asked.

"I call them dust flowers," I said. "Don't touch it. It'll fall apart if you do. A friend of mine thinks they're micrometeorite craters. Where the glass is in the middle is where the micrometeorite struck, and the pattern around it was formed by shock waves traveling in the dust. My friend says they can form only on this kind of fine-dust surface. He's writing a paper about it."

"What do *you* think they are?"

"I think they're dust flowers. We'll probably find more of them if we look around carefully."

"I'd hate to step on something that's maybe been waiting here for millions of years."

"Let's keep our eyes open."

We started off again, passing among shattered heaps of rocks and skirting around the lesser craters.

Stacy said, "You know, it seems odd to me that there should be so much fine dust on the ground around here. I thought the lunar soil wasn't supposed to be differentiated—no wind or water to sort it out into particles of varying sizes, and so forth."

"That's right," I said. "Somebody's not following the rules."

We marched along in silence. I kept looking for an open spot to pitch the tents in. After a while Stacy and I emerged, so to speak, from a forest of boulders into a clearing. The scene was extraordinary, really. It was like a natural Stonehenge, with a circle of rough columns surrounding a sort of terrace in the hillside. The circle was open to the east, and we could see far out over the flatlands. A nearly full Earth hung low over the razor horizon. I almost expected to see a sail on that dappled oceanlike expanse and surf rolling in on the beach several kilometers below us.

Stacy was superimpressed. She just stood there and said, "Glorious. Glorious. It really is." She turned to me. "No one else has ever been here, have they?"

"Don't see any footprints, do you? I've been saving it for someone special." *Someday God is going to punish me,* I thought.

"Let's get out of these suits and have some lunch," I said. "I'm starving."

I untied the roll of survival tents and laid them out on the ground, arranging them so that their door openings faced each other. The openings in tents of the kind I had are round, surrounded by a complicated flexible gasket. You can seal up a single tent with its own door, or double up two tents by pressing their door gaskets together. The gaskets are supposed to interlock tightly when the tents are filled with air.

I held up the entrance of one of the tents to allow Stacy to crawl in, dragging the food case and the blankets. Then I crawled into it. Crouching on my knees, I carefully sealed the two tents together.

"That looks airtight," I said. "Let's see what happens when I let the air out of one of these reserve bottles. If it doesn't hold, we'll have to call it off and go back to the base."

"That would be miserable," Stacy said, poking me playfully in the backside.

I opened the valve on the air bottle. The tents stirred like living things, then ballooned into a pair of dome shapes.

"It's like being inside a waterbed mattress," Stacy remarked.

"Or two jellyfish kissing," I answered, watching the other tent through the transparent plastic walls of our tent.

Stacy began to spread the blankets on the tent floor. "Why did we bring two tents?" she asked.

"For storage. When we take our suits off it'll be like having two extra people in here."

"So long as they don't want any lunch. Did you notice what's happening to the blankets?" she asked, holding up a

ripped-off handful. "Looks like vacuum and sunlight aren't good for wool."

"They were getting pretty worn out anyway."

"How's the inflation going?" she said.

"Looks okay so far," I answered. The two tents, joined at their doorways, had become rigid. The air temperature had leveled off at twenty-five degrees centigrade, and the air pressure was holding steady at an alpine two hundred thirteen millibars.

"Can we take off our suits now?"

"Let me go first." I said. Cautiously I rotated the locking ring on my suit collar. Nothing happened. So I removed my helmet. The air in the tent felt fine. On my cheeks I could feel the cheery warmth of the nearest boulders.

"It's great," I said, disconnecting my backpack hoses. Soon we were both shucking ourselves out of our vacuum suits.

In her long johns, Stacy looked like a tax-free million. She removed her inner gloves and socks and sat twiddling her toes at me and smiling. I gathered up our suits, helmets, and boots and passed them through the now-rigid doorway into the other tent. That made enough room in our tent for us to spread out the blankets. I kept my backpack with us and shoved Stacy's through the doorway into the other tent with the rest of our gear.

"All righty," I said, unlatching the food container, "luncheon is served at noon, under the stars. We have chicken, cold, and French bread, hot. We have slaw, tomatoes, and chilis. Have a glass of this good rosé, my dear Captain Cramblitt." I poured some wine into our glasses. Then I dished up big platefuls of everything. We lay down together on the blankets, resting our backs on my backpack.

"Pancho, this is delicious," Stacy mumbled through a mouthful of Porkner's warm bread.

"Yep. My compliments to Cookie and I'm so glad he's not here now," I joked.

After two hours I was feeling pleasantly tight around the middle. Stacy was pouring refills for us from our second bottle. The atmosphere in the tent was tropical. The brilliant earth, blazing cobalt, turquoise, and white, shone down on us. We lay hips touching, Stacy's head on my shoulder.

I raised my glass to the home planet. "Here's to everybody who happens to be looking at us right now. Here's looking at them." My speech was only a little slurred.

"They can't see us," Stacy whispered, finishing her wine. "We're in the new-moon phase right now."

I turned to her and said, "Well, here's looking at you, anyway," and what the hell, I kissed her on the mouth. She kissed me back, clutching at my neck.

"Guess what we're having for dessert," she whispered into my ear, sending goose bumps along my arms and down my back.

"I want my inhibitions back again."

Well, I never kiss and tell, but I will say that Stacy and I peeled each other out of our remaining clothing. I threw the food box and our long johns into the other tent with the other stuff. Infrared from the ground and the surrounding boulders shone on our naked bodies, but it was nothing compared to the glow that was in the tent already. Her breasts flushing dark rose, Stacy spread herself on the blankets and held her arms out to me.

Now you're not going to believe this, but I hesitated at this point. I was, after all, an old space hand, and the open doorway leading to the other tent had been troubling me. There was no reason to worry about it, but open hatches of any kind hover in my mind's eye until I get up and close them. Most of us out here are like that.

"Don't go away," I said, rising to my knees. I found the tent's door, a flat disk of flexible, transparent plastic, rolled up in a corner. I unrolled it and pressed its gasket into place around the circumference of the doorway between the two tents.

"Now I can give you the attention you deserve," I said, and I embraced her. Stacy snuggled in my arms and gave me a kiss. I really was enjoying every moment of this.

While Stacy was tickling the lobes of my ears, we were interrupted by a strange noise. It sounded like a sudden release of steam. The total silence of the lunar mountainside had seeped into our unconscious during the afternoon, and this uncanny sound made us leap off the floor. There was one second of panicky thrashing as we disentangled our arms and legs. I crouched like a cornered alley cat, glaring around at the motionless landscape outside the tent. I didn't see anything. Then I noticed Stacy was staring goggle-eyed at the entrance of our tent.

"Holy Mother of God," I moaned. The other tent, the one with our stuff in it, had become detached from the tent we were in. The two door gaskets had separated, the air had escaped, and now the other tent was lying collapsed over our suits, our helmets, our boots, our underwear, the food container, Stacy's backpack, the dirty dishes. All of it was out there in the clean, fresh vacuum I had been talking about. We were left buck-naked in the tent with nothing but the blankets and my backpack.

Stacy gulped for several seconds. "Well," she finally said in a small voice, "now we won't have to wash the dishes."

There was only one reason we weren't already dead of explosive decompression. I had sealed the door of our tent after getting rid of the last of our clothes. I could see my vacuum suit and helmet less than a meter away through the transparent plastic of the tent. I studied Stacy's backpack. A little red tag was sticking out of the air-regulator compartment. For some reason, the safety on her air bottle had blown, allowing the bottle to vent freely in the sealed tent. The excess pressure had blown the door gaskets of the two tents apart. The storage tent lost its pressure suddenly; if it

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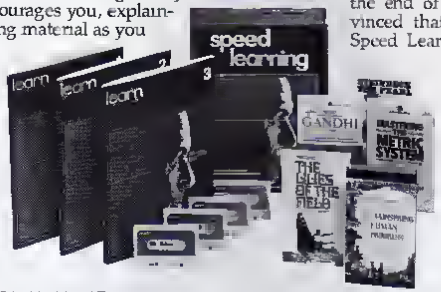

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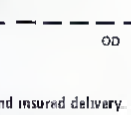

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hadn't had all our equipment in it. It probably would have flown away like a released balloon. Our own tent was holding air just fine, although the plastic door was bulging outward unnervingly.

I dragged my backpack toward me and looked at the readouts. Four hours, at the most, of reserve air and CO_2 absorption. The arm's length of vacuum that separated us from the radios in our helmets might as well have been millions of kilometers. Our ass was really in a sling, and my face must've shown it as I looked up from the backpack.

Stacy covered my hand with hers. As calm and beautiful as an angel, she said to me, "Don't be afraid, Pancho."

Guilt replaced terror in my wretched soul. "N-no," I said. "We're not dead yet, eh, Stacy."

"Although we might as well disregard the chances of anybody finding us out here by accident," she said firmly.

Oh, yes. And my own stupid fault, too.

"Well, I shouldn't have pressured you into bringing me out here," she said.

"Don't say that, Stacy. I always think I know what I'm doing. *Don't I ever!* By this time she was holding me, stroking me. There I was, lower than a crater's bottom, and *she* was trying to comfort *me*.

The sky over our heads was black. The stars were waiting to see what I could come up with. "Whatever we do, we'll have to do it soon," I quavered. "Any suggestions?"

Only two. The first one is, we say the hell with it, hope for rescue, and have a good, but short, time."

"I'm not up to it."

"Forget it. The other idea is to open the entrance of our tent and try to grab one of the helmets before the decompression kills us."

"Now I'm *really* not up to it."

"Nothing to it. You get the helmet and seal the door. I let out all the air from your backpack reserve bottle to repressurize our tent. One, two, three. Then we radio for help."

"I could never reclose the door gasket fast enough."

"We could wrap ourselves in strips of blanket, mummy-style, really tight, to prevent embolism."

"Darling, it sounds like a brave way to commit suicide. If we can't think of anything else, we'll try it, all right?"

"Okay," she said, crestfallen.

"Besides, the blankets are falling apart," I said, holding one up. The blankets had become so dried out and flimsy that they were turning to shreds as we moved around in the tent.

There was a long silence. We sat huddled, arms around each other, like a pair of monkeys in a thunderstorm. Stacy had been doing her best to encourage me. Her proposal to chance letting the air out of our tent was a long shot, but it was basically practical. Definitely worth a try. But I couldn't face it right away. She was a better man than I was.

Stacy started to droop a little. I hugged her more tightly, and she straightened up again. "Damn it! I visualized the path we had walked from West Limb. Just a short walk, if we didn't stop for sightseeing and fooling around. Between the rocks, the ground was smoother than usual for the moon, like a beach made of fine ash instead of sand. We could do it barefooted. I was beginning to have a thought.

"Stacy—"

She responded with a loud sniff. Then she said, "I'm sorry. I thought I was being brave. It's just such a damn rotten break—"

"I should be shot for getting you into this," I said. "When we get back to the base, you should turn me in for disciplinary action."

"I'd definitely will. Corrupting my morals—" By this time tears were running down my face, too.

"Listen, Stacy, there's another thing we can do. We can try to walk back to the base. We could stand the tent on its edge and roll it along from the inside. We'll just leave all our stuff here. There's enough air in my backpack for us to make it if we start now."

She thought about it for a moment. "Why not?" she said, finally. "Even if the tent rips and we depressurize, we won't be any worse off than we are now, will we?"

"Nope."

"Let's do it," she said, jumping up and pulling me to my feet.

I lifted up my backpack and hung it on my back, tucking the dangling air and coolant hoses under one of the shoulder straps. Stacy helped me adjust the harness to fit my naked torso.

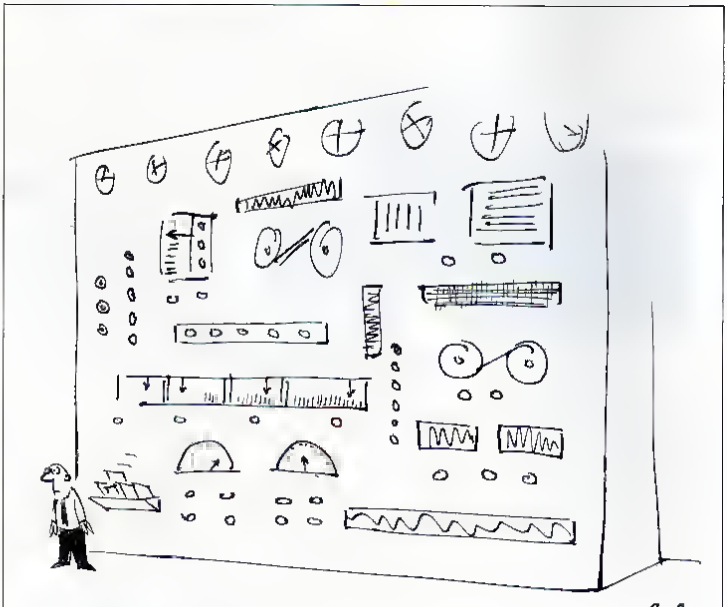
Stooping, we both pushed against the wall on one side of the tent, trying to tip it over. The plastic felt icy cold against my hands.

"Try to shuffle your feet toward the edge of the floor," I said. The tent slowly rolled onto its side, the scraps of blanket sliding downward as the tent floor tilted upward. The rim of the tent flattened on the ground. It was like standing inside a huge flat tire. The floor of the tent was now a wall to my right. Since it was no longer resting on the ground, it was bulging outward almost as much as the dome roof on my left side. The floor was made of the same kind of transparent plastic as the dome was. I tapped on it to knock off the dust that stuck to its outside surface. Very little dust actually fell off, but at least we could see through the material.

"Okay," I said. "Luckily we're already facing the way we want to go. Stacy, stay close behind me. The idea is to step along carefully and make the tent roll like a wheel on its edge."

"I hope we don't have to make any sharp turns."

We took a tentative step. As I put my weight on the plastic that curved up in front of me, it stretched until my foot was on the



"Take a card, any card."

ground. Alarming stress wrinkles developed in the dome and floor. Abruptly the tent lurched forward. Stacy fell against me from behind. We both staggered, but we managed to keep the tent upright.

"What happened?" I asked Stacy over my shoulder.

"When I picked up my foot, the tent rolled forward and pushed me into you," she said. "If we want the tent to roll smoothly, I've got to take my trailing foot off the ground at the same time you put your leading foot down on the plastic. We'll have to march in step. I'll have to hold on to your backpack."

"Jesus Christ! All right, forward, march. Left, right, left, right, left, right."

And so it went. The tent rolled along like a big wheel, wobbling this way and that, but never quite falling over. Whenever we came to one of the huge boulders, we would walk a little to one side of the edge of the dome, forcing the tent to curve its path in that direction. Occasionally we had to stop and put the tent into reverse. Generally, I followed the footprints we had made on our way to the picnic site, but as we came to more open country, I started taking shortcuts. I carefully avoided the rims of any craters more than a few meters across. I didn't care to find out whether we could develop enough traction to climb up out of one of them.

Things went better than I'd hoped. We moved steadily downhill with me still counting cadence until Stacy yelled at me to shut up.

On and on we trundled, the tent's arches flattening in little craters, sharp little rocks jabbing my soles. As we tramped out of the dust area into coarser soil, I started worrying about puncturing the tent. There wasn't a single damn thing I could do about it at all. Stacy was cussing under her breath with pain as she marched behind me.

The blankets had turned to scraps and fuzz by this time, sliding down to the lowest part of the tent as it rotated. I attempted to walk on the stuff, but the effort threw Stacy and me out of step.

"Even if we had our boots with us," I said, "we probably couldn't wear them in this tent. The cleats would hurt the tent worse than the ground outside does."

"Yeah," said Stacy. "Let's keep moving."

I didn't have a watch, but we must have gone on that way about three hours. We left the boulders behind us, and the air grew chilly in the tent. If the ground hadn't been warm, we would have had trouble with frostbite. The pocked fields of the moon were around us. It seemed as if we were making our way down the sides of an endless ash heap. My bare skin cringed from the sharp stars overhead.

"At least it's a nice cloudy day," Stacy said.

"What?"

"On Earth. We can see where we're going."

"Oh."

I wondered whether we could jump the tent over an obstacle if we had to. I was taking bigger chances, leading us into unfamiliar ground, trying to make our return to West Limb along a more nearly straight line than the route we had taken to reach the place where we had our picnic.

As we got closer to the base, the sloping side of Hevelius trended more to the west. The sun began to peep among the undulating hills on our right horizon. When we came to the first long strip of sunlight shining directly on the ground, it was like stepping on a hot griddle.

"Yow! Back up, quick!"

"Is your foot burnt?" Stacy asked.

"No, thank God."

"Will the tent plastic be able to stand the heat?"

"Oh, sure. It's designed for use on hotter surfaces than this. But we'll need to protect our feet with something."

We allowed the tent to topple over. Then we sat down for a breather.

"How far do we still have to go?" Stacy asked me as we bound our bruised and blistered feet with strips of disintegrating blanket.

"Less than a kilometer. The base is right around the corner of that ridge. Good thing, too. I had taken advantage of our halt to inspect the condition of our tent. The plastic was frosty and scratched and was obviously starting to wear out.

After tying up our makeshift booties, we got the tent up and rolling again. The remaining distance had to be covered more slowly than we had been proceeding. We were forced to go from one patch of shade to another. Crossing the strips of sunlight was hell. I felt as if I was being roasted in a bonfire. At each stopping place in the shade I tried to plan the next sunlight crossing so we could as much as possible avoid running over rocks. The tent plastic was beginning to make little crackling noises with each step we took. I kept slogging away on my throbbing feet. Whatever was bad for me was worse for Stacy, I knew.

At last, the base buildings came in sight. I never thought I could be so happy to see that dump as I was just then. "Stacy!" I cried. "You see that? We're almost there!"

I couldn't see her behind me, but I could feel her leaning heavily on my backpack.

"Don't stop now, honey. We're getting there," I said doggedly, pacing on. There were no more sunlit places to cross. I had to consider the problem of how to get inside the buildings. The quickest thing to do would be to head for the buggy hatch, the only airlock big enough to allow us to roll the tent inside without collapsing it first.

I explained all this to Stacy while we approached the buildings. "Fortunately, it'll be easy to get somebody to cycle the airlock for us," I said. "The trail to the buggy hatch runs right under the picture window of the staff bar and lounge. My instincts tell me it must be about Happy Hour now. The bar will be full of people. It'll be easy to attract their attention—"

Stacy came to an abrupt halt, jerking on my backpack so hard that I almost fell.

"What did you say?" she said thickly.

"Huh?"

"You expect me to walk in front of the West Limb Base staff bar and lounge during Happy Hour on Friday night *stark naked*?"

"Stacy," I said, turning to face her, "we're lucky to be *alive* and—"

She burst into tears. "I can't. I won't."

She had been carrying me through an ordeal so harrowing that it still gives me the creeps just thinking about it. We were sunburned salmon-pink, our feet were bleeding, we were in deadly danger just standing there. She had bolstered my morale and kept me from despair. This was the first crack in her bravery and her sense of humor I had seen during the whole terrible thing. Some other short-tempered son of a bitch might have raised his voice at that point, but not I.

I held her close, then looked her up and down. My hands ran up her back, caressed her hair, fondled her breasts, rubbed against her downy belly. I almost wasn't aware of what I was doing.

"Stacy, Stacy, darling," I choked. "You'll be the most beautiful thing any of them has ever seen, you know." Just then my left ear popped. It had always been the sensitive one. The air pressure in the tent was falling. We had finally sprung the dreaded leak!

Stacy felt it, too. She grabbed the straps of my backpack and whirled me around.

I stifled the impulse to bolt. "Double time!" I barked. "Leftrightleftrightleftright!"

We were lucky again. Though fog was forming in the tent, I could see that the buggy hatch stood wide open. This was in violation of base safety directives, but I'll be eternally grateful to whoever was responsible. With me in front and Stacy clinging behind, we bustled across the open space in front of the window.

I caught a glimpse of round eyes, open mouths, and hands holding drinks in suspended animation. Porkner just happened to be tending the bar that night. He later told me that it was the only dead silence he had ever heard in that place.

Stacy and I ran into the airlock so fast that I got a black eye colliding with the inside door. Icepicks in my ears, heart slamming, I pounded at the airlock controls through the tent plastic. I managed to hit the EMERGENCY CLOSE button; the outer door clanged down. The tent folded around us as the airlock roared itself full of that wonderful air.

I staggered against the wall, fighting the tent. Stacy sat down hard on the floor. We were both gasping for air. I was about to say we had made it, or words to that effect, when I became aware of the sound of trampling feet and the murmur of voices from behind the inner door. The Happy Hour stampede had arrived.

Stacy ripped the plastic door off the entrance of the tent and stepped out. She said through clenched teeth, "I'll kill the first bastard who—"

"Hey! Suarez! You all right?" It was Porkner's voice, coming over the airlock speaker. He had won the footrace down the corridor from the bar to the buggy hatch. I jumped out of the tent and palmed the lens of the TV camera that surveilled the airlock.

"We're all right," I said into the intercom grille. "We, uh, we need some clothes."

Already taken care of. Porkner's voice answered. "We've got a red light on the airlock panel out here. We'll have to open the hatch by hand. Stand by."

Stacy and I stood to one side. After much talk and clanking, the hatch opened a crack, and Porkner's arm came through, proffering a couple of white tablecloths. Blessed be the name of Porkner, and I'll never malign his spaghetti again.

Stacy and I emerged discreetly togaed to the plaudits of the multitude and entered the dusty buggy bay. Stacy was escorted to her quarters, and I had to answer a lot of questions. There were some sly remarks about my, ah, alleged physical state, which had not gone unnoticed as we sprinted past the picture window. I always say that it's up to us pioneers to point the way forward, as it were.

As for my relationship with Captain Cramblitt, her goodbye kiss at the shuttle pad the next day seemed promising. The next time I saw her she asked me whether I wanted to go skiing. We were on the north polar icecap of Mars at the time, but that's another story. ∞

NEXT OMNI

INTELLIGENCE

LANDSCAPES

ROCKET

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ARTIFICIAL INTELLIGENCE—A computer at MIT is conducting psychiatric examinations by analyzing patients' words and phrases, incorporating his own experience as a model; a physician at the University of Pittsburgh is programming a computer to make clinical diagnoses; a robot system recently developed at SRI International sports both eyes and a sense of touch, enabling it not only to see what it's doing but also to sense when a bolt isn't screwed in properly. We are now in the Age of Artificial Intelligence, in which machines can talk, see, and reason. Next month *Omni* details breakthroughs that are moving us beyond the Computer Age.

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ZERO

CONTINUED FROM PAGE 102

iment in human nutrition, as well as in solar physics and Earth resources, astronauts had to record everything they ate, or didn't eat, and why.

For the food people, the first crew reported from orbit: "The chili has been the most troublesome dish in the whole menu from the standpoint of mess. When you open the cellophane top, it explodes, and great cubettes and gobbets of chili go flying all over. It's bad news. It's so bad that we've decided that the next and last time we have chili on the menu, which is on day twenty-eight—and we've already cleaned up and are in the process of deactivating—we can't afford that kind of nonsense. So we're going to substitute fillets from the frozen overage for the chili and you can make your menu calculations accordingly. End of message."

When astronauts met cosmonauts aboard the Apollo-Soyuz Space Test Project in 1975, they sampled the Russians' tubes of caviar, dried fish, citrus candy and miniature loaves of pumpernickel bread. It was the end of an era in manned space-flight and the last time Americans would see such variety in space foods.

Space-shuttle crews won't revert to slurping out of plastic bags or subsisting on uniform food packets, but their menus won't be nearly as bold or individualized as those of the *Skylab* astronauts. With four to seven people on each flight, to be picked from an international pool of applicants, the job of tailoring personal preference menus gets too complicated. Instead, everybody will be served the same meals, and menus will be repeated every six days. If you don't like what you get for breakfast, you can go to the contingency storage locker and exchange your sausage for bran flakes. In all, there'll be 100 food items and 20 beverages to choose from.

On the first six shuttle missions—the orbital flight tests (OFTs)—crews will be checking the handling characteristics of the vehicle. They will fly without the shuttle galley now being built at General Electric's Valley Forge Space Center in Pennsylvania. This means there'll be no hot water and no oven, so all menus have been designed to be eaten at room temperature. Even though a suitcase-size warmer has been developed that will be carried along to heat foods and beverages, the meal plan has not been changed.

Meal 1: dried apricots, breakfast roll, granola with blueberries, vanilla instant breakfast, grapefruit drink.

Meal 2: ground beef with pickle sauce, noodles and chicken, stewed tomatoes, pears, almonds, strawberry drink.

Meal 3: tuna macaroni and cheese, peas with butter sauce, peach ambrosia, chocolate pudding, lemonade, and Life Savers in assorted flavors.

The fully operational galley will be a

model of efficiency, where one crew member can prepare seven meals in 23 minutes. Part of the convenience comes from the fact that you can't really cook in zero-g. Imagine trying to chop a weightless onion, sift flour, or attempt any of a zillion recipes that count gravity as their unwritten but essential ingredient. Shuttle meals are assembled from precooked food modules, with one-person portions of every selection packed in stackable containers that snap into oven or serving trays. To be a mess sergeant on the space shuttle, you need never have boiled water, although facility with jigsaw puzzles might help.

Some of this enviable simplicity, as well as many foods for zero-g, has already appeared on the commercial market. Tang, practically synonymous with *astronaut*, actually predates the moon shots by years. NASA purchased it from General Foods, and General Foods capitalized on the good press of the space program in those days. The opposite fortune befell Pillsbury, which developed Space Food Sticks under Air Force contract and recently had to change the product's name to Diet Sticks to boost sales. Space isn't the selling point it used to be.

In 1974 NASA cooperated with the Texas Department of Public Welfare and other agencies on a pilot project called Meal System for the Elderly, distributing 10,000 *Skylab*-type dinners to appreciative men and women from Austin to Galveston, all of whom lived outside the reach of urban meals-on-wheels programs. Aside from their ease of preparation and high nutritional standards, the products needed no refrigeration, so a month of menus could be shipped by parcel post with no risk of spoilage or contamination. Now Oregon Freeze Dry Foods, Inc., a long-time NASA contractor, markets Easy Meal to retired people, boaters, and homeowners in disaster-prone areas. Similar suppers are available from Sky-Lab Foods, Inc., of Elmsford, New York. A case of six dinners, all different, costs about $12.

The secret of long shelf life is a flexible foil package originally developed by the U.S. Army Natick Research and Development Command in Massachusetts. Colloquially called a wetpack, this pouch will probably replace the tin can within your lifetime. Anything that can be canned (cooked under heat and pressure and sealed in its own liquid) can be wet-packed—with some added advantages. Foods processed for foil packages require less cooking, which means they retain more of their natural texture and color. The foil envelopes take up less space, but so far industry can't fill them at the tin-can speed of 1,000 per minute.

The irradiation process NASA uses to preserve meats is now used in Germany and Japan. But not here. Although cobalt-60–treated foods are not radioactive, the Food and Drug Administration considers them research products not yet approved for general distribution.

Whatever wizardry has been applied to space food thus far—whether to sterilize, compress, or dehydrate it—some natural food has always been the starting point. But for its newest project, just funded in fiscal year 1979, NASA will try to build food from scratch, thinking ahead to the days when sojourns may give way to long-duration space missions or even settlements in space. Most unusual for NASA, whose scientists are used to focusing on the present mission and perhaps the one after, the new program has an experimental time frame of several decades. It's called CELSS (sounds like "sells") for Controlled Ecology Life Support Systems, and it combines audacious dreams of space conquest with fundamental questions about human survival. What are the basic nutritional requirements? (No one knows the precise answer to this one, beyond "recommended daily allowances" and time-honored guidelines about basic food groups. We endure because our bodies can extract the nutrients they need from natural foods.) But creating foods with the right ingredients will demand much more understanding.) Also: what combination of texture, flavor, color, and smell makes a palatable food? And how cleverly can foods be combined into menus at low cost to keep people thriving? How should foods be produced? Is it best to copy Earth agriculture? Could you synthesize acceptable food substitutes? How will crews respond to drinking water recycled from their own urine? Will their fecal wastes be converted to fertilizer or be used as raw material for chemical food synthesis?

Russian investigators tested a ground-based closed environment, Bios 3, for a six-month period, from December 24, 1972, to June 22, 1973. The success of the experiment—the degree to which the system stayed closed—ranged from 82 to 91 percent, depending on the type of green plants used. The men tended the plants, which turned exhaled carbon dioxide into oxygen, which the men breathed while they harvested, ate, and digested their crops, and the water went round and round.

Within the next ten years, predicts Frank Samonski, chief of the Environmental Control and Life Support Systems Branch at the Johnson Space Center in Houston, Americans will achieve 95-percent closure in a similar attempt. And according to biochemist Paul Rambaut of JSC's Medical Research Branch, we may see a limited application in space by the turn of the century, when NASA might need to support large numbers of people for months at a time while they build a solar-powered station or something similar.

"If we mounted such a construction project today," Rambaut says, "we'd have to send stored food. But in a couple of decades clear alternatives may exist. And if we can't provide fresh food in orbit, I'm betting that we'll get around the psychological hang-up of recycling wastes."

So am I.

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networked here, and the next eight are to be shown this autumn. The rest will be shown after next Christmas. In the United States they're going to start in September and be shown right through. We're in production on number fourteen now and in great haste to finish, as our American delivery date is so soon.

"We did the shows originally without American participation. With all due respect, we wanted to do our own thing, to do it our own way, and so we stuck our necks out and spent the money without any commitment on foreign distribution, which is the only way we have of turning any profit. We've tried to make each show individually rather than to use the conveyor-belt method."

There have generally been different directors, designers, and casts in each show, though Dahl serves as host for each program and only two writers, Robin Chapman and Ronald Harwood, wrote the initial nine episodes. "Each program," said Rosenberg, "was a creature of its own, which fairly often had a different approach, mounting, style, and pace from the others."

Whereas American series have a constant week-to-week or episode-to-episode budget, the individual episode costs of *Tales of the Unexpected* were dictated by their production needs. 'Lamb to the Slaughter' lent itself to studio presentation and was, in fact, the only program shot exclusively indoors. It was the least expensive program we did. On the other end was 'Man from the South,' our first episode. Shot entirely on location in Jamaica, it's the most expensive show to date.

"When *Tales of the Unexpected* was first scheduled for the spring, we were rather disappointed with the time slot chosen for it. We had hoped for a weekday evening, when audiences are generally home and in for the night. Instead, we were placed around ten on Saturday nights, opposite *Match of the Day*, one of the most popular shows in the country. The network told us that they were trying to build up their Saturday-evening lineup and thought we could be a plus to them there. I'm happy to say that most of the Dahls beat out *Match of the Day*. That had never been done before. Nothing ever came near it.

"When we started out, we were doing one show at a time, finishing it before we began the next. Now, because of the time pressures over delivery, we've had to overlap. At this point I've just completed one, I'm in the early stages of rehearsal for a second, and I finish shooting a third later this week. Again, because each program is an entity apart from the others, each takes different amounts of time to shoot. It varies from show to show, depending on how much film or videotape we're using, where the locations are, how much studio time is needed, and what the character of the program is in terms of weather requirements, size of cast, location, and so forth. The shortest we've done is two or three days, while the longest is two weeks. For us it's the only way of doing it.

"Now that we've made our sale to America, the people over there are always giving us little words of advice, little tips about what we should do with the show. They want us to alter our presentation of sex, our presentation of violence, and other things, to please their audience more. That always surprises me because we think we've produced quite a civilized series, despite the element of the macabre. But there it is. One cannot really please audiences over there with exactly the same material that will please our viewers. It's a difference in attitude toward sex and violence but more than that it's a difference in attitude about ways of approaching the television medium.

"We want to create entertainment, but there is also a good deal of time spent trying to make this entertainment convey a few other things, whether they're ideas or even original production designs. We try to give our viewers a little more than just the surface excitement that characterizes most of American commercial television."

If his shows do well, Rosenberg expects a second series to follow. The only hitch is that while the first 24 episodes are all based on Dahl's stories, the next will not have that advantage. "We'd love Roald to do more, but he's a slow, meticulous worker. The stories we've done have been the product of thirty years of his work. He's written others, but the ones that we haven't done were out of the question, like his World War II flying stories. Our American distributors are keen on the idea of our continuing, and we're all for it. Our only qualification is that we must have time to do them properly. Choosing the material, writing the scripts, getting the cast, and so on. We shall press along at speed, but we won't sacrifice quality to reach an impossible deadline."

Rosenberg poured another cup of tea and pondered the sugar bowl. "It's not worth the aggravation."

The plots of *Tales of the Unexpected* are disarmingly simple for the most part, and this may hurt the series in the constant battle for high ratings. Viewers who will be tuning in should be warned that mystery and suspense are not delivered on a par with contemporary American work. Even *Charlie's Angels* episodes are more deftly structured for the "unexpected" element.

Watching the Dahl series is much like tuning into a vintage *Twilight Zone* or Alfred Hitchcock episode. You'll probably figure out the plots and the twist endings without much trouble. The pleasures of this series can be found in the fine performances and the particularly well-designed look of the sets, costumes, and locations. The British here again demonstrate the high quality of their video productions. OO

"The bad news is, you've got the worst case of trapped gas I've ever encountered. The good news is, I'm prepared to offer you a thousand dollars for the mineral rights."

FILM

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Meyer readily admits that the idea of removing several timely elements from his picture was not his own "I owe a great debt of gratitude to Mary Steenburgen, who plays Amy in the film Because she was absolutely convinced that *Time After Time* was going to be a classic she insisted on changing things to make it more timeless When she was picking her clothes for example she chose things that wouldn't date On several occasions she changed lines of dialogue to make them more 'classic' For example, she was supposed to say 'I don't know if I'm crazy or on *Candid Camera*.' Mary insisted on dropping *Candid Camera* because no one would know what it is in twenty years

"At its best, the Victorian Era represented a period of civilized rationality that is lost now And H G Wells is the perfect incarnation of that age, a man for whom no topic was too dangerous to talk or think about His reason coupled with compassion, makes for a very civilized person The character of Wells in *Time After Time* is a bit arrogant at the beginning stuffy He has all these outlandish theories about the future-as-Utopia, which turn out to be totally wrong His most terrible discovery is that going forward to 1979 is actually a regression of human progress, as evidenced by the irrationality that he sees

"He can't look at an advertisement for laxatives on television without seeing that he knows less about the human anatomy than do millions of American schoolchildren who watch this ridiculous stuff on television every day In that way the movie provided me with a vehicle for my own anger and disgust with a great deal of the present, from rock and roll to the misuse of the English language Trying to talk with people becomes an obstacle course for Wells in the film."

Time After Time is a wonderful adventure, richly veined with humor and given added depth by its unlikely but charming love story The cast, headed by Malcolm McDowell, David Warner and Mary Steenburgen, is superb The men mix a blend of Victorian prudery madness, and ingenuity while Ms Steenburgen projects a liberated innocence reminiscent of Jean Arthur Meyer's career on the rise since *The Seven Percent Solution*, has been given a classy shove forward

A sequel to *The Time Machine* has been in the planning stage for years Titled *The Return of the Time Traveler* it will mark George Pal's return to the screen after a series of failed films during the Seventies Asked whether *he* would be interested in doing a follow-up to *Time After Time*, Meyer smiled mischievously "If there *is* a sequel it won't be made by me But I know what it will be about It's the adventures of Wells and Amy in the past when she becomes Susan B Anthony" DC

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work with any form and to tweak its vocabulary," he says, "to find out whether it's possible to express a wider band of propositions than is normal within that format. *Exposure* [released this spring] is having a look at whether rock music can appeal to the head as well as to the foot. *Frippertronics* [an instrumental LP slated for September] tries to extend the emotional and intellectual dynamic of Muzak.

"The third album, in the fall of 1980, will be *Discotronics*. One approach I might try on it, for example, would be to use environmentally derived sounds as an alternative to the traditional rhythm section—a baking tray as a snare drum, a doorbell very speeded down to give you the bass drum, the sound of a sewing machine. Each of these forms of music has its own expectations that one can work with. You have to have the friction and expectation is a good friction."

Fripp assembled the vocals on *Exposure* from readily available sources to produce an uncommon form of personal documentation. Besides having former clients Gabriel, Hall, the Roches, and others handle the studio singing, he constructed a strange yet simple collage of verbal curiosities collected on a modest Sony pocket-cassette machine. "NY3," for instance, contains a neighborhood quarrel that Fripp bootlegged through an open window last summer. "Street people are doing 'real' vocal lines over the backing track. The discussion that begins 'Disengage' has Fripp's mother being interviewed about his early toilet training, and 'You Burn Me Up'" results from a tape he had of the Shivapuri Baba, a one-hundred-thirty-six-year-old Indian swami who knew Queen Victoria. One track comprises an entire 40-minute lecture by Fripp's mentor, the philosopher J. G. Bennett, compressed to three seconds by running it some 800 times faster.

Considering the sometimes bizarre sounds he achieves, Fripp's musical equipment is minimal. He plays a 1959 Les Paul Black Beauty guitar, a pedal board with the cheapest volume pedal he could find ten years ago, a Cry Baby wah-wah, and a Foxy Lady fuzz box. They're all standard models, nothing is modified at all. The only technological addition Fripp came up with was a knock-off switch, which gave him another circuit carrying an extension pedal board with seven extra-effect items. Unfortunately, he could never remember which of about 12 foot switches was depressed, so he abandoned the devices a few years ago.

The unique Frippertronics instrumental sound is obtained through a tape-looping process developed by friend Brian Eno. Placing two Revox tape recorders side by side, Fripp records his guitar playing on the left machine and almost instantly has a playback across on the right. This playback is returned to the first machine and fed into the current signal, so that a layered sound is built up. The result—whether hovering, pulsing, echoing, or revolving—is a steadily ambient effect (thus Fripp's reference to Muzak), unlike conventional melodies that "go" somewhere.

"My written music has releases," he says, "but Frippertronics, which is improvised, doesn't necessarily have a climax. That churning inevitability has to do with the actual technique, but it also has to do with a personal sense of who I am. Novelist Thomas Hardy, who came from Dorset as I did, had that same relentless quality of the remorselessness of fate."

There are two kinds of Frippertronics previewed on the *Exposure* album—"pure" pieces, such as "Water Music II," and a wide variety of "applied" tones designed to accompany previously written songs. "If you have a piece of music with only one mode all the way through, that's fine," Fripp noted. "But using applied Frippertronics with rapid changes in modulation within a song can be incredibly hard work.

"For example, since 'Here Comes the Flood' takes a minute or two to change key on the loop process one has to work gradually with the decay. I had to make thirty different loops—record one for the period a chord existed. Stop. Record the next loop which would be appropriate to another chord—all the way through the song, side by side, building up different harmonies."

In concert Fripp can either incorporate successive guitar passages into a gradually woven aural tapestry or press a foot switch to take himself out of the circuit to solo over his own backdrop. One night in Canada, though, the technology broke down, and Fripp had to clamp two paper clips and a wooden spatula for stirring coffee onto the left Revox in order to save the show.

"One gracefully concedes to the inevitable," he said with a shrug. "In five years' time life generally will be a bodge, and if I am able to deal with things at hand—the science of bodging, which is a real art—I'll be able to do things the dinosaurs won't be able to handle."

Below, a "friendly" statement issued by Fripp in his own writ and a partial discography of post-Crimson albums on which he played a major role.

"Leaving the [music] industry between 1974 and 1977 to pursue alternative education, notably at the International Academy for Continuous Education, Sherbourne House, me returned to music gradually in New York, and during the summer of 1978 I undertook to work in the marketplace for a period of three years. This commitment will complete in September 1981, during the Year of the Fripp."

Albums: *Exposure* (Polydor), *Evening Star* (Island), *No Pussyfooting* (Island), *Here Comes the Warm Jets* (with Brian Eno, on Island records). DC

FORUM

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the slaughter of baby seals is not different from the slaughter of beef cattle is the biggest of these traps, despite the vast and substantial difference between two such concepts. When cattle are slaughtered, it is to provide meat for eating, hides for clothing and, when the carcass is processed, bone meal for fertilizer so that the whole cycle may begin anew. The same general case exists for fish. [Horsman cites fish as undergoing a similar "slaughter".] In addition to the meat provided by fish, oil is extracted from some species and fish too can be used for fertilizer. But can the same be said of seals? Not to my knowledge. I have yet to see seal meat available on grocery shelves, the only people on this continent who depend on a daily diet of seal meat are the Indians of the north and the Inuit, neither of whom are at issue here. No, the baby seals are hunted primarily, if not exclusively, for their lovely white pelts, from which expensive fur coats are made. To equate the slaughter of baby seals, then, with fisheries and livestock ranching is a gross distortion of the facts.

Horsman points to the importance of sealing on the Newfoundland economy. Citing the supposed disastrous effect a ban would have on the incomes of Newfoundlanders, he makes it appear that Newfoundlanders can do nothing but hunt seals. I don't imagine that Horsman would want to offend the very people he is trying to defend, yet this condescending attitude of his cannot be very encouraging. What sort of self-esteem is there to be found in clubbing baby seals over the head?

There are those who defend the seal hunt as being an integral part of the Canadian heritage. This is true. But, reminiscent of the white man's treatment of the Indians, it is a part of our heritage of which we can hardly be proud.

Drew Snider
West Vancouver, B.C., Canada

Binding Religions

I would like to reply to Eugene Marquis's letter in the May 1979 Communications.

Marquis implies, incorrectly, that the essence of religion is ritual. Actually, rituals are characteristic not only of religion but also of politics (e.g., saluting the flag), common courtesy (e.g., "May I help you?") and many other aspects of life.

What distinguishes religious ceremonies from other human and animal activities is the reality to which they refer. Religious ritual refers not only to the visible reality of the group and its history but also to that invisible reality that the Judeo-Christian tradition calls God.

It is interesting that Marquis refers to bonding rituals because the root of the word *religion* means a binding together. The elements linked in religious binding are not of only man and the creation but also God.

Certainly we may see a carry-over from animal rituals to human ceremonies. However, man remains the only known species that deliberately and consciously links himself with his Creator.

David M. Bowring
Toronto, Ont., Canada

Ocean Encounters

"Gulf Dream" [May 1979] is one of the most informative pieces of scientific research I've ever encountered.

The concept rates with the Manhattan Project in its potential for being man's next major source of unlimited energy minus the risks and deadly side effects that we are now experiencing with conventional forms of nuclear energy.

The lack of funds to investigate the viability of Coriolis 1 was mentioned. I suggest that its engineers contact the Ocean and Energy Systems at TRW, in Redondo Beach, California. TRW's theory that energy can be extracted from the oceans differs somewhat from theories mentioned in Scot Morris's article, but there may be some room for collaboration and for comparing ideas. TRW's project deals with the systems aspect of ocean thermal energy conversion. The time is right to explore all avenues.

Robert M. Rice
Washington, D.C.

Off Target

I wish to point out a fundamental error in the first paragraph of Roy A. Gallant's "Target Earth" [Explorations, June 1979].

The event of June 30, 1908, in the Tunguska region of central Siberia, Russia, did not involve a meteorite, as Gallant asserts.

What it was is the subject of much heated discussion, but it certainly was not a meteorite—unless meteorites change course after reaching the earth's atmosphere. More than 200 observers in the region gave detailed descriptions, showing that the Tunguska object had actually changed course from an eastward approach to a westward one.

Ballistic-wave evidence indicates that the object performed a flight correction in the atmosphere. No natural object can carry out a maneuver. Its approach into a trajectory angle nearly identical to the reentry path used by modern space vehicles, along with its cylindrical shape, indicates that it may have been a controlled craft from some other planet. The evidence on this comes from a series of studies done by Professor Felix Zigel, aerodynamics professor at the Moscow Institute of Aviation. Other Soviet rocket and aviation experts, such as Kazantsev, Manotskov and Liapunov, have confirmed Professor Zigel's opinion, based on similar studies of the area.

Lawrence J. Fenwick
Toronto, Ont., Canada

Look for an up-to-the-minute report on Tunguska in an upcoming Omni. —Ed

Speeding Galaxies

Among the list of Honorable Mentions for *Omni* Competition #3 published in your June issue was a submission by Jim Walker of Miami, Florida in which the writer asserts, "Evidence shows that the distant stars are moving outward with acceleration." I would be most grateful if you could inform me whether this statement is factual and not a misstatement by Walker. I am aware of the discovery by astronomers—using red-shift measurements—that galaxies are generally speeding away from us at a velocity in direct proportion to their distance from us. I was not aware, however, that it has been discovered that they are *accelerating*. If that were the case, it would seem to contradict the Second Law of Thermodynamics or, at least, imply that the universe is not a closed system.

If Walker was correct in his assertion, would you please inform me of the evidence he refers to. If he was incorrect, I believe you should inform your readers, since, by printing his question, *Omni* implies that it has scientific merit.

R. Peet Brown
Upper Montclair, N.J.

Scot Morris replies: *Mr. Brown's point is well taken. The outer galaxies are receding from Earth at a faster pace than the nearer galaxies, but whether their speed is changing or is not, no one knows.*

Catalyst

The diverse articles on intelligence drugs, cybernetic wars, penetrating the microcosmos, harnessing the Gulf Stream, and Red Star in orbit featured in the May issue of *Omni* had the impact of further awakening my mind to the significant forces that are shaping the world in which we live.

One of the central questions facing our civilization is: How do we magnify our potential and ability to promote the healthy development of individuals, organizations, societies, and nations? *Omni*'s contribution has been to serve as an intellectual catalyst in further stimulating new perceptions and alternatives that can contribute to this process of development.

Roberto Anson
Gaithersburg, Md.

Likes 'Dark Star'

In reference to The Arts column on film [June 1979], I would like to add my appreciation to Dan O'Bannon for cowriting the film *Dark Star*. Although O'Bannon seems discouraged by its popularity, which, according to his beliefs, simply does not exist in the slightest, I would like to offer some consolation if I may. I saw this film for the first time a few months ago when it was shown by one of the cinema clubs at Syracuse University, where I go to college. I encourage people to see it, as it is extremely well made, considering it was produced in its entirety on a budget of only $50,000. O'Bannon claims it did not make people laugh, but I laughed. The idea of such concepts as a "talking bomb" was pure genius.

Dark Star was also years ahead of its time. No one thought about the possibilities of human transportation at the speed of light (except the producers of *Star Trek*) or even about "hyperdrive," but the writers of *Dark Star* did, and whether possible or not, the special effects were just as good as they were in *Star Wars*, although not quite as extensive. However, this is understandable, considering the budget differences between the two.

Merritt E. Tilley III
Syracuse, N.Y.

Morbid Obesity

Dan Ross's Continuum review of the "Ultimate Diet" [April 1979] combines fact with fiction.

"The best way to lose weight is to make your stomach smaller," Ross reports in his enthusiastic review of the gastric-bypass operation. And obesity experts certainly agree. The surgical approach to massive, or morbid, obesity is based upon the dual premise that severe obesity represents a serious life-shortening severity and that long-term medical therapy usually proves ineffective.

Dr. Edward Mason, a surgeon at the University of Iowa, first performed the three-hour operation in 1969. Dr. Mason believes bypass surgery for obesity can be justified only if the risks are higher than those of surgery. "Indications for surgery need to be carefully defined, and the patient and his family should clearly understand the potential risk and benefits."

Medical experts agree that reducing caloric intake and expending more calories through exercise constitute the safest weight-loss method. Yet even this approach demands dedication and determination, thus often ending in failure to lose weight.

Like so much other faddish information, Ross's reporting pushes glamour and miracles. There is a real difference between "ultimate" and "last choice" reducing methods.

Amy Barr
Boston, Mass.

Monetary Monster?

I regret I must question the depth of your commitment to the equality movement for science-fiction writers.

You have violated the "nonnegotiable demands" of your own call to arms within the pages of your sanctum. I refer to the Last Word by Ben Bova in the April 1979 issue. Number 4 states, in part, "The term *sci-fi* must be rooted out."

Please look again at the advertisement on page 17 of the same issue. Alas, can it be that you also bend a knee to the monetary monster?

Sara Davene Stroup
Fulfurrias, Tex.

That's why we need a campaign to eliminate the usage of (ugh!) sci-fi. The science-fiction writers (and editors) have no control over the words used in advertisements. —Ed

Tending Our Gardens

I once had a friend whose wife was continually persuading him to move from town to town. "Things just aren't quite right here," she would say, and shortly thereafter they would move on in search of that "right place." I remember mentioning to him that perhaps no place would ever be the right place for her. Perhaps it was not the places these people were in, but the people they were, as they visited those places, always looking elsewhere.

As man looks toward the stars, I can't help but wonder whether much of the cause behind that stargazing is the ridiculous mess we've created for ourselves here. When it comes to complaints of having lost our desire to seek the stars, I fail to see how expanding our species out into the galaxies will serve any purpose since we have yet to prove that we humans can live with one another on our own planet.

America was once an unexplored new frontier. Look at it now. How horribly sad to think that we have come so far and learned so little!

For myself, I prefer to try tending my garden here on Earth to some degree of success before expanding it elsewhere.

Daniel W. Preston
St. Cloud, Minn.

Shades of Scales

Finally picked up my first copy [May 1979] of *Omni* today. I would like to comment on the letter from Ivor Darreg of San Diego, who thinks that pianos and everything else that use the old 12-tone scale are obsolete.

Thirty-one- or nineteen- or seventeen- or thousand-tone instruments aren't about to replace the piano. While they may be nice as novelties, they simply don't have any musical tradition behind them. When you sit down at a piano, you know you stand on a firm foundation laid down by Beethoven, Chopin, Joplin, Fats Waller, and Chick Corea. The 12-tone scale's possibilities have by no means been exhausted.

W. C. Myrvold
Signal Mountain, Tenn. DO

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ITALY'S GOLDEN AGE OF SCIENCE

EXPLORATIONS

By Dava Sobel

I've never liked science museums that offer nothing but mural-sized pages from textbooks and 'please touch' exhibits blinking and whirring and explaining themselves in tape-recorded messages. Those places are too pat, too neat. They throw you a plastic replica of some dinosaur skeleton in a bow to evolution, but they never admit that science itself has a history—full of fits and starts and theories that went extinct in the night. As a child, I would come away from such magic shows with terribly distorted ideas: that the universe had all been figured out, for example, and that nature's laws were innately obvious (to everybody but me), and that the whole scientific enterprise had sprung full-blown from the head of Isaac Newton or Benjamin Franklin or somebody like that.

But at the Museum of History of Science, in Florence, Italy, among ancient instruments that occupy three floors of an even more ancient building, I get a real sense of the sweaty, human struggle for exploration and experiment. There are so many tools of discovery housed here that only a fraction of them are behind glass, the rest stand out in the open, without so much as a sneeze guard to protect them. The lens through which Galileo first saw the four large moons of Jupiter is on display, broken by his own hand, along with two of his small telescopes (only about a meter long), one covered with paper, the other with fine Italian leather tooled in gold.

Not only was science once upon a time lavishly decorated, fluted, carved, painted, and gilded, but it hung for a while on mysticism and sacred relics. Witness, in the room commemorating Galileo's prize achievements, a case that contains the middle finger of his right hand. Mummy-pale, with the bones showing through the translucent skin, it rests inside a gold-adorned glass egg, atop an inscribed pedestal of wood and ivory. The finger points upward, and I like to think it still protests the powers that made Galileo denounce Earth's motion around the sun.

Galileo died in 1642, at the age of seventy-eight. But strange things continued to happen to him. "In the early eighteenth century," the museum's English-language guidebook says, "Galileo's body was moved from its initial resting place to its present location in the main body of the Church of Santa Croce. In that move several fingers and a vertebra were taken and preserved independently. This one remains a testament to certain tastes of that century."

Probably the oldest item in the museum's collection is an Arabic globe made in Spain around 1080. Instead of depicting the landmasses of the planet, the surface of the sphere represents the constellations. (Celestial globes like this one are believed to date back to ancient Greece, some 550 years before Christ and 400 years before the first terrestrial globe.) One of its two meridians bears the inscription, "This globe with its pedestal was made [illegible] by [illegible] the weigher in Valencia, and Muhammad his son, and the fixed stars are placed on it according to their magnitudes and diameters. It was completed in the beginning of the month of Safar in the 473rd year of the Hegira of the Prophet. God bless him and grant him perfect peace."

The museum's several dozen celestial globes were built on the idea that the earth was at the center of the universe and that the orbits of the stars formed concentric rings around it. Astrologers, astronomers, and master craftsmen constructed ever more elaborate models of this cosmic structure, even after Copernicus tried to put the sun at the center in 1543. One such armillary sphere, on the museum's second floor, stands taller than two men and is supported on a base of four bare-breasted, golden mermaids. At first glance, its wheels within wheels appear to be the cogs of a giant clock, but peering through them reveals a tiny painted model of Earth at the core. This globe is surrounded by the spheres of the seven wanderers—the moon, Mercury, Venus, the sun, Mars, Jupiter, and Saturn. Next is the eighth sphere, that of the "fixed stars."

This brass quadrant, made in 1568, was used to measure height of heavenly bodies above horizon

and the band of the zodiac. The ninth circle represents the Primum Mobile, or the Prime Mover (you know who He is), whose shell is politically decorated with the coats of arms of the Medici and Lorena families. Santucci dalle Pomerance started this work in 1588 and finished it in 1593. Unlike the many armillary spheres that were used to teach cosmology or to make observations or mathematical descriptions of celestial mechanics, this one he built was purely for ornament.

Other museum pieces based on heavenly motions are sundials of all description and their less well known counterparts, the night dials, or nocturnals, which indicated the hours of darkness by the relative positions of certain stars.

During those years when the workings of nature were so far from obvious, the lives and work habits of scientists were much more solitary than they are today and much more subject to scorn and censure. But between 1657 and 1677 a collaborative group of experimentalists met regularly in Florence to conduct research in the mathematical, physical, and natural sciences. The men called themselves the Accademia del Cimento, from the word *cimentare*, which is what goldsmiths do to test the purity of precious metals. The accademia was out to test and establish the purity of nature's laws. The museum displays some of their beautiful glass thermometers, woven and coiled into unique shapes. Some of them look far too fragile to have endured three centuries. The accademia's clinical thermometers, called tadpoles, were festooned with ribbons that tied them to the patient's arm. Inside the frog-shaped glass vial, small solid spheres of various colors, each one of a different density, floated in liquid. As the patient's body heat warmed the liquid, the practitioner read his temperature from the depths of the spheres.

Later medical developments represented in the museum are plush-lined cases of ivory-handled surgical instruments and an entire wall of detailed models depicting obstetrical complications observed at the Ospedale di Santa Maria Nuova.

On the third floor, above the surveying tools and the microscopes, is the "sala di meccanica"—a fun house full of whirligigs that demonstrate physical principles such as acceleration and inertia. Of course, these are hand-carved and inlaid, and some are fiendishly clever—like the model that shows how to draw water simultaneously from four wells by using only two horses.

The museum itself is among the oldest buildings in Florence—a twelfth-century castle that was once part of the city walls. It spent time as a fortress and was partially destroyed when the Arno overflowed its banks in 1333. In 1574 the magistrates of the Tuscan government occupied it, followed by the National Library in the nineteenth century and the museum in the twentieth. The museum had existed at various addresses around the city since 1775, moving as the collection was enlarged and more money became available. Today it includes a library for visiting scholars. Soon it will also have a small projection room for showing films, and there will be a planetarium.

The price of admission is cheap, only 1,000 lire (about $1.20), not counting the air fare to Italy. And if you like art museums, the Uffizi Gallery is right next door.

SCIENCE ATTRACTIONS IN FLORENCE

"La Specola" Zoological Museum—Via Romana 17. Clemente Susini's famous wax models of anatomical details are on display here along with a vast zoological collection including beautiful corals, Somalian fauna, and many rare marsupials and birds.

Museum of Old Musical Instruments—Library of the Conservatory, Via degli Alfani. Includes instruments from before the French invasion and a fine collection of stringed instruments by Stradivarius, Amati, Galliani, and others.

Museum of Geology, Paleontology, and Physical Geography—Via Lamarmora. Contains the richest paleontological and geological collections in Italy. The museum dates from the Medici period. ∞

EARTH

CONTINUED FROM PAGE 16

melodramatic On the back cover of *The Night Country*, for example, he stands starkly under a streetlamp, at night, his overcoat collar turned up against the cold Mickey Spillane might have struck such a pose for a dust jacket Professor Eiseley stood for these photos, and he must have helped choose them He saw himself this way—as a stern lawgiver in a trenchcoat You almost want to laugh, despite the nobility of the face

Eiseley often referred to himself as a refugee a perpetual stranger I think he was, and I think he had the blindness of the perpetual stranger in how he went over with others To get the good out of any writer one must put up with a little something or other and with Eiseley that something is often the Grand Pose

The dedications of his books are interesting, too Only one "For Mabel," his wife is addressed to a living person The rest are to the dead It's as if Eiseley had been more comfortable with people when they had become geological returning to dust again *The Unexpected Universe* is dedicated "To Wolf, who sleeps forever with an Ice Age bone across his heart the last gift of one who loved him" *The Night Country* to "My Grandmother, Malvina McKee Corey who sleeps as all my people sleep by the ways of the westward crossing" *The Immense Journey* to "Clyde Edwin Eiseley who lies in the grass of the prairie frontier but is not forgotten by his son" The dedications are remarkable for their unashamed emotion for their melodrama, and for a certain ambiguity Is he addressing Wolf, or that Ice Age bone across Wolf's chest? Is he addressing his father, or the grass of the prairie frontier? Which one, Clyde Eiseley or the frontier grass is he crediting with his paternity?

The key to a lot about Eiseley, I think lies in *The Mind as Nature* his slimmest book, but one of his best In it he writes of his childhood "I was born in the first decade of this century conceived in and part of the rolling yellow cloud that occasionally raises up a rainy silver eye to look upon itself before subsiding into dust again That cloud has been blowing in my part of the Middle West since the Ice Age Only a few months ago flying across the continent, I knew we were passing over it in its customary place It was still there, and its taste was still upon my tongue

"We never had visitors No minister ever called on us, so the curtains were never raised We were, in a sense, social outcasts We were not bad people, nor did we belong to a racial minority We were simply shunned as unimportant and odd

"The neighbors were justified in this view My mother was stone-deaf, my father worked the long hours of a time when labor was still labor I was growing up alone in a house whose dead silence was broken only by the harsh, discordant jangling of a voice that could not hear itself My mother had lost her hearing as a young girl I never learned what had attracted my father to her I never learned by what fantastic chance I had come to exist at all Only the cloud would know I sometimes think to this day only the yellow loess cloud rolling impenetrable as it was when our ancestors first emerged from it on the Ice Age steppes of Europe, or when they followed the bison into its heart on the wide American plains

"I turned over the bricks of our front sidewalk and watched ants with a vague interest There grew up between my mother and myself an improvised system of communication consisting of hand signals stampings on the floor to create vibrations, exaggerated lip movements vaguely reminiscent of an anthropoid society ..."

And then his father came home Clyde Eiseley, his son writes, had been an itinerant actor declaiming "raw Shakespearean melodrama to unsophisticated audiences

> *Eiseley's gift was to see his own planet as if it were another He was the perpetual alien on his natal sphere. Some sort of earthly miracle is at the core of each of his essays*

in the little Midwestern "opera houses" He had a beautiful, resonant speaking voice That voice greeted a "curiously deprived and solitary child—a child whose mother's speech was negligible and disordered and which left him for the greater part of his early childhood involved with only rudimentary communication and the conscious rebuffs of neighbors." The voice recited Shakespeare to the boy contributing "another ill-understood world of haunting grandiloquent words at which his playmates laughed"

Thus, if Eiseley has steered us right the strong sometimes archaic poetry of his prose is the Bard's, the resonance of his voice Clyde Eiseley's, the deliberation of his speech a vestige of that anthropoid communication with Daisy Eiseley (For Joseph Conrad English was a second language, and partly because of that partly in spite of it Conrad became a great English stylist For Loren Eiseley, *language* was his second language Words had more weight with him because they came so late.) Thus, too the lack of humor in his writing (A strange, solitary, unhappy boyhood is not good for jokes.) Thus in his books Eiseley is usually the sole protagonist—Eiseley and whatever plain or wasteland he is standing on at the moment (Other humans in his stories always feel distant and much smaller They come alive only when, as in writing of Charles Darwin, Eiseley is discussing their intellectual component.)

The Mind as Nature is Eiseley's plea for the strange child—for the queer seemingly stunted, late-blooming genius like his own Such may seem a prescription for genius in many fields but it applies especially if I'm not mistaken to writers of science fiction Had Eiseley been born anywhere but under the "loess cloud," I think he would have written that species of fiction and would have written it as well as anyone has done His stories often verge on it He has some of the flaws even, of a Kilgore Trout Eiseley's dialogue as in much science fiction often reads corny and unlikely I suspect he overheard most conversation in his imagination not in real life

His gift was to see his own planet as if it were another He was the perpetual alien on his natal sphere He was able to see Earth's true miracles as truly miraculous Some sort of earthly miracle is at the core of each of his essays

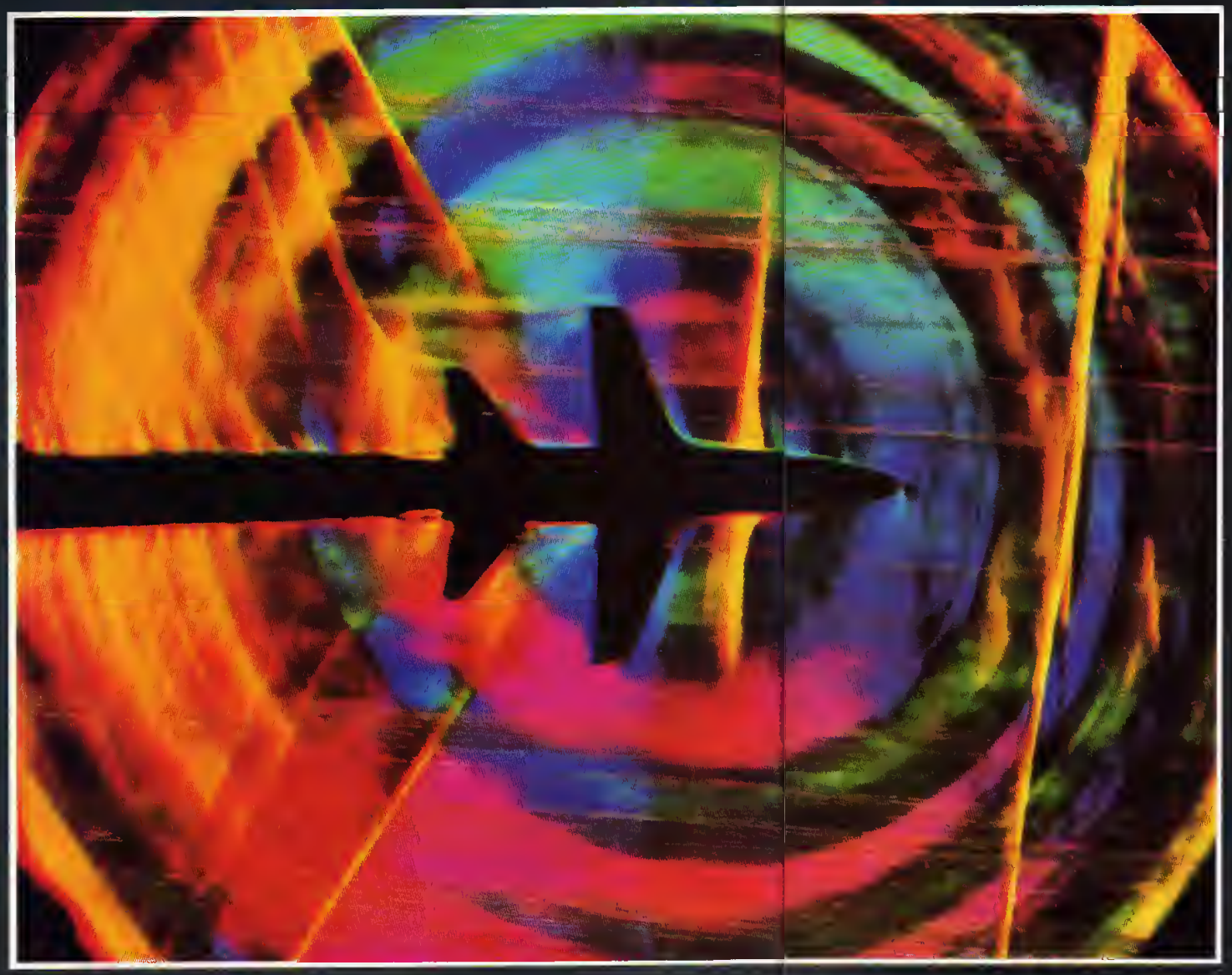
In his story "The Judgment of the Birds" Eiseley is standing, once again in the Badlands He looks at the stark country around him "The ash of ancient volcanic outbursts still sterilizes its soil and its colors in that waste are the colors of that flame in the lonely sunsets of dead planets Men come there but rarely and for one purpose only the collection of bones" A flight of birds races southward toward him Eiseley has a revelation

"It may not strike you as a marvel It would not perhaps unless you stood in the middle of a dead world at sunset but that was where I stood Fifty million years lay under my feet fifty million years of bellowing monsters moving in a green world now gone so utterly that its very light was traveling on the farther edge of space The chemicals of all that vanished age lay about me in the ground"

He looks down at the chemicals—black streaks of carbon the stain of iron in the clay "The iron did not remember the blood it had once moved within the phosphorus had forgot the savage brain

"I had lifted up a fistful of that ground I held it while that wild flight of southbound warblers hurtled over me into the oncoming dark

"There went phosphorus there went iron there went carbon there beat the calcium in those hurrying wings Alone on a dead planet I watched that incredible miracle speeding past It ran by some true compass over field and waste land It cried its individual ecstasies into the air until the gullies rang It swerved like a single body it knew itself and lonely it bunched close in the racing darkness its individual entities feeling about them in the rising night And so crying out to each other their identity they passed away out of my view" ∞



PHENOMENA

One of the most difficult problems of aerodynamics is captured in this extraordinary photograph by Dr. Gary Settles. Using the schlieren technique—a method that shows differences in air densities by disturbances in refracted light—Settles photographed an early test model of the space shuttle breaking the sound barrier in a wind tunnel at NASA's Ames Research Center. Such transonic speeds produce strong shock waves that buffet the craft and make it difficult to control. These invisible wave patterns can be highlighted by the schlieren technique. The colors shown here illustrate shock patterns created at speeds of Mach 1 and above and are helpful in perfecting aerodynamic designs.

Settles took this photograph with a Hulcher 70-millimeter framing camera and High Speed Ektachrome film. The design of this schlieren system is his own. **DO**

COMMUNICATIONS

CONTINUED FROM PAGE 10

Hands Tied

If we continue to curtail our NASA exploration program, and if we sign the SALT II pacts placing limits upon the development of space-exploration technology, is that not like tying both our hands behind our back and promising the bully that we won't hit him first?

I could accept a strategic-arms-limitation treaty if it were *coupled* with a national commitment to explore space vigorously, much in the same manner as we once put a man on the moon after seeing *Sputnik* in the sky. Otherwise, *no way* do I want us to give up without a struggle.

William J. Cox
Long Beach, Calif.

Faulknerized

As a certified scuba diver who has experienced the rapturous beauty of coral-reef diving, I have a word to say about the underwater photography of Douglas Faulkner ["The Universe Below," May 1979]. More!

Ron Elkins
Bloomingfon, Ind.

Satisfaction Guaranfeed

Paul J. Nahin's narrative of imagined events adorning the pages of your May issue brought me to an unequivocal state of decided sensory gratification and intellectual stimulation.

Or, as the Language Clarifier would put it: I *liked* the story! Thanks.

James Tucker
Blackstone, Va.

Raw Meat

I wonder whether you, or anyone else familiar with *Alien*, questioned the meaning of fhe name of the starship *Nostromos*. Well, I did, and if my translation is correct, it was an appropriate, although morbid, name for the astronauts' craft.

Nostromos (Latin, neuter of *noster*, 'our,' and *omos*, Greek, 'raw meat') literally translates to *our raw meat*.

Sorry, Dan O'Bannon. I let the cat, er, excuse me, Alien out of the bag.

Bruce E. Linderman
Arnold, Pa.

Concerning the movie *Alien*, your write-up [June 1979] shows you are a master of understatement!

Donald Wright
Garland, Tex.

Loch Look

I find the Loch Ness monsfer one of the more interesting earthbound mysteries, and I was intrigued by the efforfs of those scientists who took part in "Return to Loch Ness" [May 1979]. They themselves realized their inability to obfain on land data concerning the creature. So they puf recording devices underwater to meet it on its own terms. I suggest going one better. Use minisubs fo search out the deeper depths of the loch. This would, at the very least, rouse the aquatic animal and make information more easily accessible. Eventually science and exploration will triumph in solving the riddle of Loch Ness.

Jason MacCallum
Brome, P.Q., Canada

Minisubs and similar submersibles have already been used in the loch. Unfortunately, the great depth and murkiness of the water have rendered them ineffectual. —Ed.

Magic Birds

Tully Scott [Forum, June 1979] was wrong when he said that the "magic birds" (airplanes) never returned and that the Cargo Cult died. If you watched *In Search Of* or read *National Geographic*, you would know that the Cargo Cult is still going sfrong in New Guinea—because of the "magic birds" bearing the television and photographic crews to film them.

After all these years the Cargo Cult actually got airplanes to fly to New Guinea, pay a lot of attention to them, film them, pay them, and generally make life more interesting for them.

Alan Vaughan
San Francisco, Calif.

Partly Baked Idea

This is a suggestion concerning *Omni* Competition #6 [April 1979].

A successful competition will produce a great number of partly baked ideas. The winners' names will be published in this magazine, and perhaps many anofher reader will wish he had sent in his own entry. I propose that this contest be made a permanent feature of *Omni* if the response justifies it.

"The Scientist Speculates" was a Four-Star Establishment in a field of greasy spoons. Maybe *Omni* will become a continual feast for those who have the time and resources to investigate partly baked ideas.

Donald W. Velsor
Prattville, Ala.

Space Lottery

Because priorities have changed or budgets have tightened, or for whatever reason, money does not flow the same way it did in the Sixties. Because of this, NASA has had to economize and cut back.

I know a way you can get $100 million easily. Just sell lottery tickets at $10 a shot. Winner gets a "ride" [on the space shuttle] (assuming he has proper medical qualifications). If 10 million people buy a ticket (which isn't many out of a nation of 220 million), you'll have your 100 million. But let's say 50 million buy a ticket, which still isn't that unreasonable; then right away you'll have half a billion dollars. To get more money than fhat, just run another lottery.

If the shuttle has room for four payload specialists, just pick a flight that's only using one or two and add a passenger. And the passenger wouldn't be so much dead weight, either. There could be an agreement on fhe lottery ticket, some kind of liability waiver, whereby he would agree to participate in certain medical experiments. You'd never be short of guinea pigs.

Actually, I think *everybody* in the country is going to buy a ticket, not to mention the people who buy 10, 20, or 1,000.

Roberta Gluzband
Chestnut Hill, Mass.

Human Software

In the January interview I. J. Good proposes that we create a computer more intelligent than a man, which would then be programmed to design a still more intelligent computer, and so on.

A computer's intelligence is determined primarily by its software. Producing a more intelligent computer means devising new languages and programs. The nature of the hardware is not critical, although a computer with human intelligence would presumably need a memory capacity incomparable with fhat of the human brain.

The hardware would not even have to be electronic. The human brain itself could be used instead of a computer.

If we can produce software that would make a computer more intelligent than a man, we might as well produce better software for ourselves and thus create a *man* more intelligent than any man is at present. These first ultraintelligent men (and women) could then carry on the work, just as fhe ultraintelligent computer is supposed to do in Dr. Good's scenario.

Anyone who would like to participate in such a project is invited to write to The Bootstrap Society, P.O. Box 42999, M.S. 620, Houston, Texas 77042.

Lyle Burkhead
Houston, Tex. ∞

GAMES

ANSWERS TO GAMES (page 144)

POTPOURRI

1. HORSE RACE. Switch horses—each knighf rides the other's horse.
2. REUNION. Four persons. A brother is present without his wife but with his son, and his sister is present without her husband but with her daughfer.
3. BACKWARDS. Disregarding such esoterica as the backdive, the Fosbury Flop high-jump technique, and the demolition derby, the fhree events won by moving backward are: rowing, backstroke swimming, and tug-of-war.
4. NUMBER. 6,210,001,000
5. NINES. $99^{99/99}$
6. MISPRIT. "NINE MEN FANNED IN NINE INNINGS."

TOP TEN FORMULAS

A = 1, B = 5, C = 8, D = 9, E = 10, F = 3, G = 7, H = 4, I = 6, J = 2

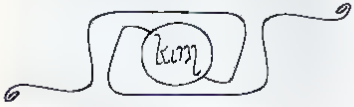
COMPETITION

By Scot Morris

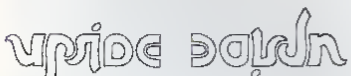
Scott Kim, a young graduate student at Stanford University's computer science department, has developed a remarkable talent—the ability to twist letters into unexpectedly plastic forms and to shape words into beautiful symmetric designs. Consider the strange lettering on a cake Scott baked for his parents' wedding anniversary. His father's name, LESTER, was in chocolate frosting. Turn the cake

upside down and his mother's name, PEARL, appears in white.

Scott's own signature is an elegant example of his curious art. It reads exactly the same upside down.



Scott's most elegant creation is UPSIDE DOWN, a word picture that describes its own symmetry. Examine the design closely. Turning the "U" of UPSIDE into the "N" of DOWN was simple enough, but then came the task of making three letters into one—turning a "PSI" into an upside-down "W." Scott did this by emphasizing the downstrokes of the "P" and the "I," to set boundaries on the "W," and he snugly nested the curves of "P" and "S" to weld the middle of the "W." He separated the "I" and the "S" by employing a favorite trick—the dot over the "i" is a strong cue when it is at the top of a word (the only other letter that has a dot is "j") but is



completely ignored when it is at the bottom. A single squared-off corner is sufficient to suggest the "D" in UPSIDE. The eye doesn't notice this corner in the inverted "O." Finally, the crossbar of the "E" serves an ambiguous role, suggesting a left edge in the "D" of DOWN. It was, in fact, the dual role of this crossbar that prompted Scott to use a "flattened" lettering style in the first place, which maintains the ambiguity better than does a style made of thin lines.

What's the purpose of such a design? "It's just fun," Scott says. "I like to see how far I can push a letter before it becomes unreadable. It's a challenge to make a design work visually and conceptually."

Some famous names illustrate the various sorts of symmetry possible. MOZART fits neatly into the upside-down form, appropriate for a man who composed two-part canons that could be played in both directions simultaneously, the second melody being the first inverted. J. S. BACH is symmetric around a diagonal line, prompted by the 90-degree orientation of the curves in "J" and "S" and by the lucky coincidence that all the letters in BACH are already bilaterally symmetric. The signature for KURT GÖDEL, the mathematician famous for his incompleteness theorem that revolutionized mathematical theory, has

mirror symmetry around a vertical axis.

Some of Scott's other letterings can't be

called symmetrical but are unique in their neat, appropriate forms. Part of his FALSE IS TRUE and his DREAM fades off like a reverie to a vanishing point on the horizon.

He continues to explore new possibilities. Last year his Christmas card introduced a new kind of lettering—top-bottom symmetry around a horizontal axis, with all letters upright. The five letters in MERRY form an exact mirror image of the nine letters in CHRISTMAS, especially remarkable because both words are scanned in the same direction. As if to celebrate his achievement, he signed the card with a bilaterally symmetric KIM

These "designatures"—half-design, half-signature—have an immediate visual

and intellectual appeal. After seeing them, many people can't wait to take out pen

and pad to see what they can do. After I showed a photo of Scott Kim's LESTER/PEARL anniversary cake around, Chuck Black, a Colorado high-school student, was inspired to intermesh OMNI

and GAMES in a similar way.

The Competition. Send a designature for any famous person, or a unique visual play on words of the type discussed above. Print in black ink on white paper with your name and address attached, and identify the meaning of the lettering if necessary. Neatness counts. All entries must be postmarked by October 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 #9, 909 Third Avenue, New York, N.Y. 10022.

The Top Ten Equations
plus puzzles

GAMES

By Scot Morris

THE FORMULA HALL OF FAME

"The human animal differs from the lesser primates in his passion for lists of Ten Best"—H Allen Smith

The Top Ten Tunes, the Ten Most Wanted Men the Ten Best Dressed, the Ten Commandments—everywhere can be found confirmations of Smith s astute anthropological observation

Even the Central American country of Nicaragua has gotten into the act It has issued a series of postage stamps commemorating *las 10 formulas matemáticas que cambiaron la faz de la tierra* ("the ten mathematical formulas that changed the face of the world) It was a noble and worthy gesture for the tiny nation to honor not nationalism but the spirit of the highest intellectual achievements of all mankind

Nicaragua's ten 'formula stamps' are displayed here The equations themselves are presented in the upper-left hand corner of each stamp Also given here are verbal descriptions (A-J) of the Top Ten Formulas Can you match them up?

Answers page 142

1

2

A. A rudimentary equation allowing exact tallying and exchange Without it primitive man couldn t know the exact number of sheep and cows he had or how many people were in his tribe The discovery of this formula led directly to the rapid development of commerce and later measurement

3

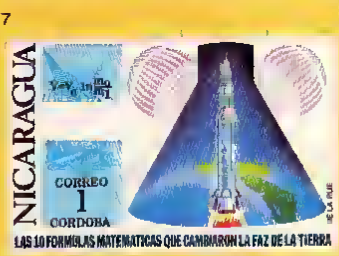
4

B Pythagoras's formula for the relationship between the three sides of a right triangle This most central principle of geometry provided a way of computing length indirectly allowed one to calculate the distance of a sea voyage or the height of a building, and advanced the sciences of surveying and mapmaking It is commonly known as the Pythagorean theorem

5

6

7



C Louis de Broglie s 1923 equation showing the wavelike nature of all particles—'matter waves It led to the development of modern optics and transistors with great implications for the development of radio television computers spaceships, military weapons and the powerful electron microscope

D Archimedes s formula for the principle of the lever, which underlies engineering devices including brakes door hinges, crowbars, and even nuts and bolts

E James Clerk Maxwell s formula equating electricity and magnetism Visible light was placed in relationship to other forms of radiation such as X rays and the formula predicted the existence of radio waves that could make possible long-distance communications on land and sea and in air and space It was one of the few classic equations untouched by Einstein

F Albert Einstein's formula for the equivalence of matter and energy, the root of the nuclear age It says that a small quantity of material can be converted into

8

a large amount of energy, which we can see in spectacular and violent form, in the atomic and hydrogen bombs, or in more peaceful form, in reactors that generate electricity for homes and factories

G Konstantin Tsiolkovsky's equation derived from one of Newton's laws of motion, giving the changing speed of a vessel as it burns the weight of its fuel

9

10

Without it, launching spaceships to the moon and planets and into orbit around the earth would be impossible

H John Napier's logarithm formula, which allows us to multiply or divide large numbers rapidly by simply adding or subtracting their logarithms The impact of the formula on astronomy and navigation was enormous and comparable to today's computer revolution

I Ludwig Boltzmann's equation revealing how the behavior of gases depends on the constant movement of atoms and mole cules It is applied in steam and internal combustion engines In the gaseous reaction used to make modern drugs and plastics, in understanding the weather and in exploring the violent processes of the sun stars, and distant galaxies

J Sir Isaac Newton's formula for gravi tation Before Newton's time people had little idea of what forces held the planets in their orbits around the sun or the moon around the earth or even what kept men from flying off the surface of the earth into the sky Newton demonstrated that all bodies attract one another by a force proportionate to their masses and the distance between them

A = _____ F = _____
B = _____ G = _____
C = _____ H = _____
D = _____ I = _____
E = _____ J = _____

A PUZZLE POTPOURRI

1 SLOW HORSE RACE Two knights seek the hand of Princess Priscilla in marriage Each boasts that he owns the fastest horse in all the land So the king arranges a horse race The king, however, is not eager to have his little girl marry and he is especially unimpressed with her two suitors, so he decrees that the winner of the race, who will receive the princess's hand will be the knight whose horse crosses the finish line *last* It would seem that the race would never get under way Neither horseman would want to ride out ahead of the other But Princess Priscilla eager for marriage, thinks of a way to outwit her overprotective father She whispers instructions to the two knights that ensure that the race will be fair What does she say?

2 FAMILY REUNION Norman Pos tells of a gathering attended by a father, mother son daughter, brother sister cousins nephew niece, uncle and aunt If all have a common ancestor and there has been no consanguine marriage what is the minimum number of persons who could be present at such a reunion?

3 BACKWARDS Name three sporting events that are won by moving backwards

4 AUTOBIOGRAPHICAL NUMBER Write a ten-digit number so that the first digit tells how many zeros are in the number, the second digit tells how many ones the third how many twos and so on

5 NINES Using only six nines write a number that equals 100

6 TYPIG MISPRIT The exasperated sportswriter is ready to call it quits and cancel his column for the day The teletype machine has spewed out the following incomprehensible string of letters as the headline for a sports story

IEMEFAEDIIEIIGS

You as an alert up-and-coming reporter deduce that one of the teletype keys must be broken You translate the message and save the day Add one letter 11 times to the string of letters to produce an intelligible, albeit unspectacular headline

Answers page 142

OMNI COMPETITION Next month we will present the results of *Omni* Competition #6—partly baked ideas—in a thought-provoking selection of far-out specu lations, judged with the assistance of Dr I J Good, the master chef of the partly baked idea Meanwhile, try your hand at a new kind of art form in Competition #9 which appears on page 143 ∞

NUCHIC

LAST WORD

By Stuart Diamond

Middletown, Pa —The tourists still flock to this small town near the damaged Three Mile Island nuclear reactor The pizza parlors newsstands, and clothing stores do a brisk business in nuclear-accident mementos Inscribed T-shirts bumper stickers dinner plates and drinking mugs It is yet another example of the ingenuity and diversity of American capitalism after any major event, however depressing or disastrous

At the main intersection of town, Judy News a tobacconist made handsome profits on newspapers following the March 28 accident Today the store also sells Original Canned Radiation inscribed in black and red letters on a white soda can Filled with air Cost $2 $2 12 with tax

The bumper stickers ($1 each) say "Radiation City Middletown Pa.," or "Hell no, I don t glow" There are other snappy slogans that will tell your neighbors back home that you were at the front

The local Elks Club serves a concoction called the Bubble Buster, consisting of a shot of Scotch a shot of tequila, and a shot of vodka on the rocks Club manager David Delmler says, "The survival rate is very low"

But the real chic is reserved for T-shirts "A little nukey is good for you" says one For Three Mile Island workers the chic shirt proclaims "TMI Staff I stayed to save your ass"

Although no official estimates of nuclear tourists are available most observers say they number in the thousands The David Martin clothing store alone sells from 500 to 700 T-shirts a week for $4 or $6 apiece "The best thing I can tell you is that we're trying to make lemonade out of a lemon" says Jack Baker, the store s manager

Some scientists now predict that more nuclear power means more nuclear accidents This provides a challenge for chronic trend setters who are, however unfamiliar with the technology By observing the rules of nuclear-accident chic they can gain the desired status and acclaim amid general panic and confusion

We divide nuclear-accident chic (NUCHIC, for short) into three categories using the details of Three Mile Island as an instructive example

1 THE PLAYERS Always look for *heroes* and *villains* In general, the heroes favor people and the villains favor profit Thus at Three Mile Island the heroes were Harold Denton, the federal government s chief problem solver who saved the people from disaster, Jack Lemmon, the embattled nuclear-reactor operator who gave his life for safety in the movie *The China Syndrome*, and the Pennsylvania Consumer Advocate s Office which persuaded the state not to make utility customers pay all the costs incurred as a result of the accident

The villain is usually the company that owns the errant reactor In this case it was Metropolitan Edison which violated federal regulations and then tried to charge its customers for millions of dollars in damage Other villains were the doctors and nurses who evacuated leaving behind hospital and nursing-home patients—and also the Hippocratic Oath

Some players are *neither here nor there* Pennsylvania Governor Dick Thornburgh for example, professed ignorance of atomic energy throughout most of the accident

2 PREPARING FOR A NUCLEAR ACCIDENT If you plan to leave find out the best evacuation routes This may be difficult, since most localities in the country don t know them If you stay, stock up on bread and milk and reserve out-of-town newspapers There is always a run on them during any disaster

Get a radiation monitor You can buy a colorful, pen-shaped one that you can read yourself for $150 Or you can rent one that has to be read by a professional Hundreds of reporters and officials rented them at Three Mile Island from an obliging nuclear businessman, David Katzman of Philadelphia s Radiation Monitoring Corporation

Katzman set up shop in his hotel room Each day the potentially injured filed in and gave Katzman their badges to be analyzed—like urine samples—for $3 50 per readout Katzman inserted the badges into a computer and the computer indicated the dosage they had received Seldom did the badges show any radiation above natural levels

3 THE ACCIDENT As soon as you hear about a nuclear accident, lose weight Thin people look better on the television screen

For clergymen it is chic to give last rites Many priests in the Harrisburg area did this, getting a lot of publicity and perhaps winning new congregants

A sense of humor in the face of adversity is always chic It helps to relax people Thus What melts in the ground and not in your mouth? Answer Hershey Pa Or What s the weather forecast? Answer Partly cloudy with a 40-percent chance of survival

One local radio station reported that a woman caller asked whether it was safe to have sex within 25 miles of the damaged reactor

It is chic to know the definition of China Syndrome whereby reactor fuel melts into the ground toward China But it is even more chic to know the precise antipodal point of the reactor In the case of Three Mile Island it was not China but Diamantina a trench in the Indian Ocean

Poetry and fancy slogans are chic Former Pennsylvania Governor Milton Shapp wrote "Obviously all bond holders / Must be better protected / Before any new nuclear plants / Are ever again erected" Others chanted "Two, four, six eight we don t want to radiate"

It is chic to know some good radiation stories Example Sleeping with someone gives you an extra 20 millirems each year—as much as two dental X rays—because all of us have radioactive potassium in our bones

But the height of NUCHIC is to play with numbers in a new and revealing way The prize for NUCHIC during this first accident goes to the Atomic Industrial Forum (AIF), the trade association of the nuclear industry AIF engineers calculated that the heat from the damaged reactor raised the temperature of the surrounding areas 5/18° C Thus it said, local homeowners saved a total of 275 gallons of heating oil each day