OMNI

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OMNI®

VOL. 9 NO. 11 AUGUST 1987

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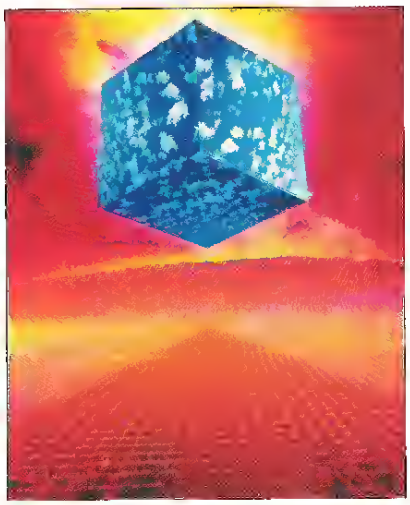

Salt Lake City–based artist Steven Hunt composed this photographic illustration to depict the contrasts in nature's relationships. The atmosphere is life-giving and protective, the vastness of dry earth and vibrant fire dominated by The Cloud Cube

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FIRST WORD

By Yevgeny Yevtushenko

"Nations are losing the ability to hear each other's heartbeats. Many international negotiations break down because they are built on mutual accusations instead of on mutual confessions."

One of the causes for the absence of idealism in our world today is the absence of a new philosophy. We need a new philosophy that will sum up all the tragedies of the twentieth century so that we can avoid another—and this time final—tragedy. This philosophy must develop a new ethics that will unite rather than divide people. Humanity is pregnant with this new philosophy, which is kicking from inside, seeking a way out.

I have no intention of offering recipes for creating ideals. Clever recipe givers inevitably fail—like the television evangelists. Not everyone is able to be a hero, but everyone has the opportunity *not* to be a scoundrel.

On the other hand, I believe there is nothing higher than the ideal of human brotherhood. Even a family will fall apart if the concept of brotherhood is missing. War between nations is *non*brotherhood. An undeclared war—envy, jealousy, gloating, insincerity, lack of frankness—against someone close to you is nonbrotherhood, too. We must conquer the nonbrotherhood in ourselves, and that will make universal brotherhood possible. Brotherhood, if given a chance, is an ideal that can be held in common by people of the most varying political and religious views.

Idealists are often laughed at. They are considered eccentric, unrealistic, and sometimes even crazy. At the turn of the century the bourgeois in the Russian provincial city of Kaluga used to laugh at the parochial-school teacher Tsiolkovsky, who made blueprints for interplanetary spacecraft. Yet he invented the principle on which our spacecraft are built. If the founder of a new philosophy could become not just international but interplanetary, people would laugh at him, too. Yet we need such a philosophy.

The twentieth century devours ideals. It gave birth to chemical and atomic weapons, the Holocaust, Hiroshima, genocide in Cambodia, terrorism, sex shops, AIDS, and one of the most debilitating drugs—television. Technical progress turned out to be a synonym for spiritual regression. The twentieth century also killed our revolutionary idealists. It murdered Mahatma Gandhi, Martin Luther King, Che Guevara, John F. Kennedy, Aldo Moro, and Olof Palme.

To the gigantic number of the starving is constantly added the gigantic number of the spiritually starved. Acknowledged spiritual hunger, however, is not terrible. What is terrible is *un*acknowledged spiritual hunger, especially when it seems like comfort. Fear of burglary makes people put numerous locks on their doors. But at the same time, they put locks on their souls so that no one can open them and see what's inside. For many the standardization of thought is not a catastrophe but a salvation. Instead of listening to the world, people plug up their ears with earphones playing music. They jog right past a mugging victim and fail to hear the victim's moans. We are replacing our eyes with peepholes on doors. Many of us living in enormous apartment buildings don't know our neighbors on the same floor and don't want to know them. Then why the hell know our neighbors on the planet?

Instead of being a window on the world, a newspaper in the hand becomes a curtain for blocking out the world. The habit of watching a visual salad of human suffering with a cloying dressing of advertising on the TV news leads to the habit of contemplating those sufferings instead of sharing them.

Think of the time we all spend at parties that are merely counterfeit human contact. Just try responding to "How are you?" seriously. Say that things are not good at home, you're not sleeping nights, you're contemplating the best way to commit suicide, and that you have lost faith in yourself and in everyone else—and the questioner will back away from you, thinking you have lost your mind. He may be having problems at home himself or may be up all night thinking about the same things, yet he can't admit it because he's afraid of appearing weak. Speaking openly of your weaknesses is human strength. Pretending to be strong is a weakness that can turn into a disease.

This fear of personal "confession" then turns into a national fear. At the same time that secret services worldwide are achieving great heights in mutual eavesdropping, nations are losing the saving ability to hear each other's heartbeats. Many international political negotiations break down because they are built on mutual accusations instead of on mutual confessions.

Calling one government the symbol of all bad on the earth, and one's own government the symbol of all good is nothing other than fear of confession. We will achieve a lasting peace on Earth only when political negotiations are built on mutual courage.

The most important thing facing us now is to save the world from nuclear catastrophe. If we do save it, will it be a world without ideals, based only on a biological deal? Estranged from one another, will we have made a cold calculation for our physical survival? Will we replace the ideal of human brotherhood with pragmatic détente, promising only temporariness and undependability? Will we give up and betray the best of humanity? Or will we recognize a world where all religious and political views are accepted?

Yevgeny Yevtushenko is an internationally acclaimed Russian poet. His book Almost at the End *was recently released by Henry Holt and Company. This piece was translated by Antonina W. Bouis.*

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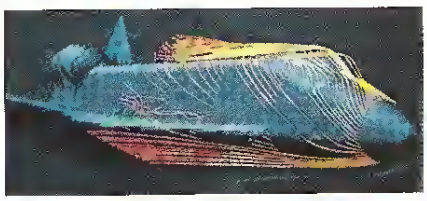

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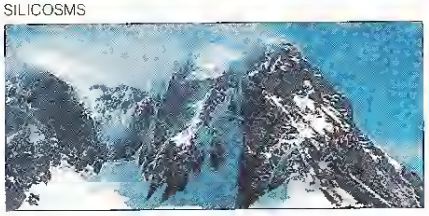

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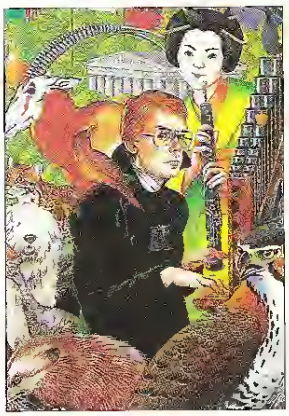

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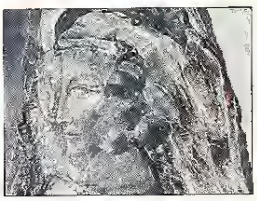


STARDUST

Dear Folks

I know it's been a while since you've heard from me. I get the same complaint from friends. I wish I could say, "Having a wonderful time; wish you were here." But this isn't like any summer camp I've ever been in. They say it's the real world. I think it's a simulation, only it doesn't fly like NASA's computerized hypersonic plane fantasies ["Silicosms," page 52]. I expect to step out the door onto Broadway one day and hear someone declare, "This has only been a test."

NASA's test flights actually remind me of my video games at home. As frivolous as it may sound, they can be very constructive, as Claude Shannon might appreciate. The seventy-five-year-old renowned mathematician, eccentric prankster, and subject of this month's Interview [page 60] has a pogo stick, a unicycle, and other toys. He even juggles. Interviewer *Anthony Liversidge* says it "reflects Shannon's lifelong interest in balance and controlled instability." I asked Liversidge if he could juggle. He can't.

Frankly, I find it difficult to juggle all the activities here at Camp *Omni*. I feel like the painter in "The Omni Alphabestiary" [page 75]—overwhelmed by the tools and products of the trade. The pictorial is an excerpt from *The Ultimate Alphabet* [Henry Holt] by *Mike Wilks*. Each painting contains objects whose names begin with a particular letter. We chose the letters *O*, *M*, *N*, and *I*, for obvious reasons. Of course, there's more rhyme and reason in Wilks's art than there seems to be here.

This is an untamed habitat and could be hazardous to my health. Some of my fellow campers have fallen prey to information overload, and I'm glad you insisted that I get all those shots. There are, however, researchers developing vaccines that might be even more effective. According to *Jeff Kluger*'s "Body Doubles" [page 48], these miracle drugs are derived from the body's own proteins. The combinations of amino acids may one day be manipulated to treat and even prevent cancer, as well as produce vaccines for diseases like AIDS.

Some folks here have discussed escaping; they talk about hiding out in Antarctica. Personally, it's not my idea of fun. It's now winter in the Southern Hemisphere, and Antarctic winds reach 40 miles per hour. A group of daring pilots, led by a Vietnam vet known as Captain America, will be there this month—soaring at dangerous altitudes, right through the ozone layer. They'll be collecting data that scientists will later analyze. As you suspected, Chicken Little is probably right. Writer *Ellen Ruppel Shell* reports ["Watch This Space," page 36] there's this hole in the sky that everyone is concerned about. The ozone shields us from the sun's hazardous ultraviolet rays. Without its protection, we might all suffer worse than I did with that really bad sunburn I got when I was eleven. Do you remember? (Yes, I'm more careful now.)

England, I'm told, is much nicer than Antarctica this time of year. That's where the annual world science fiction convention will be held. And two stories we published last year—Greg Bear's "Tangents" [January 1986], which was named the best short story of the year by the Science Fiction Writers of America, and Roger Zelazny's "Permafrost" [April 1986]—are nominated for Hugo awards. It would be nice to be there if they win.

Of course, the way travel arrangements are made around here, I'd probably end up back in Kansas. That wouldn't be entirely bad, however. I could visit Auntie Em, as well as author *Pat Cadigan* ["Patterns," page 68]. Cadigan's last story to appear in *Omni* was "Roadside Rescue" [July 1985], and her first novel, *Mindplayers*, was recently published by Bantam.

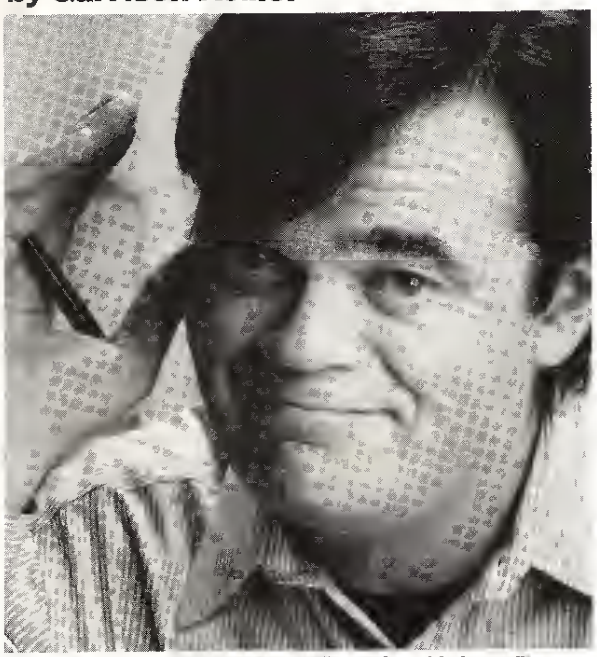
Harvey Jacobs wrote a story, too. It's about Uncle Henry, only he calls him Herman. I remember how everyone always made fun of Uncle Henry for his obsession with astronomy. Maybe the family will be more understanding after they read "Stardust" [page 44].

Anyway, I've got to go. One of the scientists in this month's issue is on the phone. It took two weeks for him to return my initial call. Following up on stories and checking facts is difficult. It's worse during the summer, when all the experts seem to be out of town. So why am I hanging around?

I surrender,
Dorothy

How to write a personal letter

by Garrison Keillor



International Paper asked Garrison Keillor, author of the best-selling books, Happy to Be Here and Lake Wobegon Days, to tell you how to write a letter that will bring joy into the life of someone you love.

We shy persons need to write a letter now and then, or else we'll dry up and blow away. It's true. And I speak as one who loves to reach for the phone, dial the number, and talk. I say, "Big Bopper here—what's shakin', babes?" The telephone is to shyness what Hawaii is to February, it's a way out of the woods, *and yet:* a letter is better.

Such a sweet gift

Such a sweet gift—a piece of handmade writing, in an envelope that is not a bill, sitting in our friend's path when she trudges home from a long day spent among wahoos and savages, a day our words will help repair. They don't need to be immortal, just sincere. She can read them twice and again tomorrow: *You're someone I care about, Corinne, and think of often and every time I do you make me smile.*

We need to write, otherwise nobody will know who we are. They will have only a vague impression of us as A Nice Person, because frankly, we don't shine at conversation, we lack the confidence to thrust our faces forward and say, "Hi, I'm Heather Hooten, let me tell you about my week." Mostly we say "Uh-huh" and "Oh really." People smile and look over our shoulder, looking for someone else to talk to.

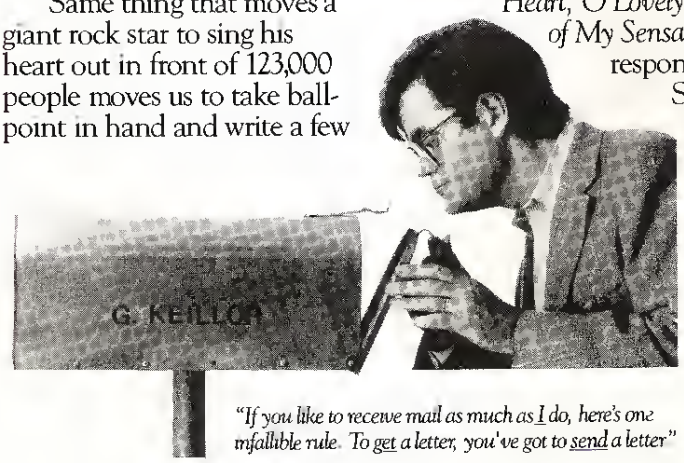
So a shy person sits down and writes a letter. To be known by another person—to meet and talk freely on the page—to be close despite distance. To escape from anonymity and be our own sweet selves and express the music of our souls.

Same thing that moves a giant rock star to sing his heart out in front of 123,000 people moves us to take ballpoint in hand and write a few lines to our dear Aunt Eleanor. *We want to be known.* We want her to know that we have fallen in love, that we quit our job, that we're moving to New York, and we want to say a few things that might not get said in casual conversation: *thank you for what you've meant to me, I am very happy right now.*

Skip the guilt

The first step in writing letters is to get over the guilt of *not* writing. You don't "owe" anybody a letter. Letters are a gift. The burning shame you feel when you see unanswered mail makes it harder to pick up a pen and makes for a cheerless letter when you finally do. *I feel bad about not writing, but I've been so busy,* etc. Skip this. Few letters are obligatory, and they are *Thanks for the wonderful gift* and *I am terribly sorry to hear about George's death* and *Yes, you're welcome to stay with us next month,* and not many more than that. Write those promptly if you want to keep your friends. Don't worry about the others, except love letters, of course. When your true love writes *Dear Light of My Life, Joy of My Heart, O Lovely Pulsating Core of My Sensate Life,* some response is called for.

Some of the best letters are tossed off in a burst of inspiration, so keep your writing stuff in one place where you can sit down for a few minutes and *Dear Roy,*



"If you like to receive mail as much as I do, here's one infallible rule. To get a letter, you've got to send a letter."

I am in the middle of an essay for International Paper but thought I'd drop you a line. Hi to your sweetie too dash off a note to a pal. Envelopes, stamps, address book, everything in a drawer so you can write fast when the pen is hot.

A blank white 8" x 11" sheet can look as big as Montana if the pen's not so hot—try a smaller page and write boldly. Or use a note card with a piece of fine art on the front; if your letter ain't good, at least they get the Matisse. Get a pen that makes a sensuous line, get a comfortable typewriter, a friendly word processor—whichever feels easy to the hand.

Sit for a few minutes with the blank sheet in front of you, and meditate on the person you will write to, let your friend come to mind until you can almost see her or him in the room with you. Remember the last time you saw each other and how your friend looked and what you said and what perhaps was unsaid between you, and when your friend becomes real to you, start to write.

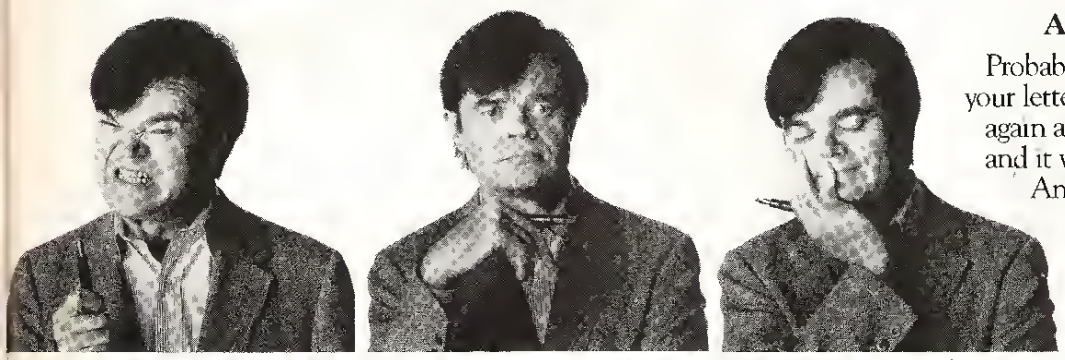
Tell us what you're doing

Write the salutation—*Dear* You—and take a deep breath and plunge in. A simple declarative sentence will do, followed by another and another and another. Tell us what you're doing and tell it like you were talking to us. Don't think about grammar, don't think about lit'ry style, don't try to write dramatically, just give us your news. Where did you go, who did you see, what did they say, what do you think?

If you don't know where to begin, start with the present moment: *I'm sitting at the kitchen table on a rainy Saturday morning. Everyone is gone and the house is quiet.* Let your simple description of the present moment lead to something else, let the letter drift gently along.

Take it easy

The toughest letter to crank out is one that is meant to impress, as we all know from writing job applications; if it's hard work to slip off a letter to a friend, maybe you're trying too hard to be terrific. A letter is only a report to someone who already likes you for reasons other than your brilliance. Take it easy.



"Outrage, confusion, love—whatever is in your mind, let it find a way to the page"

Don't worry about form. It's not a term paper. When you come to the end of one episode, just start a new paragraph. You can go from a few lines about the sad state of rock 'n roll to the fight with your mother to your fond memories of Mexico to your cat's urinary tract infection to a few thoughts on personal indebtedness to the kitchen sink and what's in it. The more you write, the easier it gets, and when you have a True True Friend to write to, a *compadre,* a soul sibling, then it's like driving a car down a country road, you just get behind the keyboard and press on the gas.

Don't tear up the page and start over when you write a bad line—try to write your way out of it. Make mistakes and plunge on. Let the letter cook along and let yourself be bold. Outrage, confusion, love—whatever is in your mind, let it find a way to the page. Writing is a means of discovery, always, and when you come to the end and write *Yours ever* or *Hugs and Kisses,* you'll know something you didn't when you wrote *Dear Pal.*

An object of art

Probably your friend will put your letter away, and it'll be read again a few years from now—and it will improve with age. And forty years from now, your friend's grandkids will dig it out of the attic and read it, a sweet and precious relic of the ancient Eighties that gives them a sudden clear glimpse of you and her and the world we old-timers knew. You will then have created an object of art. Your simple lines about where you went, who you saw, what they said, will speak to those children and they will feel in their hearts the humanity of our times.

You can't pick up a phone and call the future and tell them about our times. You have to pick up a piece of paper.

Garrison Keillor

Today, the printed word is more vital than ever. Now there is more need than ever for all of us to *read* better, *write* better and *communicate* better. International Paper offers this series in the hope that, even in a small way, we can help.

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AUGUST

LETTERS

COMMUNICATIONS

We Stand Corrected

I am outraged by the shocking misquotation of my remarks in an interview regarding Frank Davidson published in the May issue of *Omni*. Never, on any occasion, even offhand or off-the-record, have I referred to President Reagan as "vicious," a characterization totally contrary to my opinion.

As the president of one of the nation's leading technological universities and an international representative of the United States on matters of science policy, I am appalled by the attribution to me of such a patently absurd statement.

Géorge Bugliarello
President
Polytechnic University
Brooklyn

Editors' note: The remark about President Reagan was made by another source and was inadvertently attributed to Dr. Bugliarello. *Omni* regrets the error.

New Dimensions

It is possible to see into at least one higher plane described in "Dimensions" [May 1987]. Located at the forehead, the sixth chakra, a person can see a "channel" of pure energy with a pulsating boundary. Apparently, the doorway to higher dimensions exists within us.

Lyn B. Ehrnstein, President
Phoenix Research Foundation
Beverly Hills, CA

We can't expect to perceive the higher dimensions any more than Beetle Bailey can be expected to perceive the four-dimensional universe surrounding him. Religious and metaphysical tenets, however, state that we are multidimensional creatures. Our consciousness exists concurrently on higher planes. How else are we to explain phenomena such as premonitions, déjà vu, and telepathy?

The most important fact about science's so-called discovery of the higher dimensions is that it may lead to the reconciliation of science and religion.

T. J. Castle
Hendersonville, TN

Sunrise, Sunset

Thanks for Octavia Butler's fictional story "The Evening and the Morning and the Night" [May 1987]. Her creativity and style are stunning.

Joy Schwab
Philadelphia

Les Liaisons Dangereuses

Donald Goldberg's article "The National Guards" [May 1987] read like a scary, futuristic short story—all the more dreadful because it's actually happening right now. Are you now classified as potential risks to national security? I'm left wondering how we got into such trouble. I'll bet the good citizens of the USSR are wondering the same thing.

Elizabeth Rose
Harrisburg, PA

I protest Goldberg's paranoid assertions. He objects to the military use of commercial communications satellites in time of emergency. This is no different from existing plans to use civilian air and shipping fleets by the military. Those plans are viewed as prudent.

He blatantly ascribes a nefarious motive to the Department of Defense without understanding that it is merely trying to perform its constitutional function. If he doesn't like what's happening, he should get the American Civil Liberties Union or one of the telecommunications companies to file a class action suit.

Alan Hoffman
East Windsor, NJ

This Story's Got Legs

Your cute comment describing writer K. C. Cole—"and has great legs"—was degrading and offensive [Continuum, "Who Needs Women?" May 1987]. You owe an apology to women readers and writers—unless you intend to describe the physical attributes of all your writers, including bicep size and penis length.

Carol Leone
Los Gatos, CA

Editors' note: K. C. Cole herself insisted on the description "and has great legs."

MOTHERS OF INVENTION

FORUM

The Media Laboratory is a brand-new facility—$45 million ambitious—housed in a sleek I. M. Pei structure on MIT's East Campus. It's built around founder and director Nicholas Negroponte's conviction that something big and convergent is happening to the whole gamut of communications media: television, telephones, recordings, film, newspapers, magazines, books, and—infesting and transforming them all—computers. The Media Lab was set up to collect that process and lead it.

Negroponte's vision: All communication technologies are suffering a joint metamorphosis, which can be understood properly only if treated as a single subject and advanced properly only if treated as a single craft. The way to figure out what needs to be done is to explore the human sensory and cognitive systems and the ways that humans most naturally interact. Join this and you grasp the future.

I'd seen a dazzling presentation of Negroponte's a couple of years before at a "technology, entertainment, design" conference. Since then I'd heard that his Media Laboratory was mustering a number of people I had admired from afar, including Marvin Minsky, a cofounder of artificial intelligence. Minsky is a major influence on Negroponte and on the shape and direction of the Media Laboratory's research—toward what Minsky calls the "hard problems," the problems of meaning and cognition rather than just signal processing.

On a snowy Sunday afternoon at Minsky's home, I asked him why he was so interested in science-fiction writers. "Well, I think of them as thinkers. They try to figure out the consequences and implications of things in as thoughtful a way as possible. A couple of hundred years from now, maybe Isaac Asimov and Fred Pohl will be considered the important philosophers of the twentieth century, and the professional philosophers will almost all be forgotten because they're just shallow and wrong and their ideas aren't very powerful.

"Whenever Pohl or Asimov writes something, I regard it as extremely urgent to read it right away. They might have a new idea. Asimov has been working for forty years on this problem. If you can make an intelligent machine, what kind of relations will it have with people? How do you negotiate when their thinking is so different? The science-fiction writers think about what it means to think."

Science fiction is *the* literature at MIT. The campus bookstore has a collection as large as some science-fiction specialty stores. Every computer science student knows and refers to John Brunner's *Shockwave Rider*, Vernor Vinge's *True Names*, William Gibson's *Neuromancer*.

Somewhere in my education I was misled to believe that science fiction and science fact must be kept rigorously separate. In practice they are so blurred together that they are practically one intellectual activity, although the results are published differently—one in a kind of journal for honest scientific reporting, another in a kind for wicked speculation.

Every now and then you'll see a work that really combines both, examining scientific news and imagining social consequences in one breath. The most exceptional of these recently is a 1986 work called *Engines of Creation*, by Eric Drexler. I first came across its subject at a meeting of the Nanotechnology Study Group at MIT, at which author Drexler and Minsky were speaking. I came out giddy, blindsided by a future even more revolutionary than what's coming in computers and communications.

The basic premise of the MIT study group and of Drexler's book is that we are rapidly acquiring the technical ability to craft individual molecules out of atoms, and when that is accomplished, it will change everything we know. *Nano* means "one billionth," to indicate the unimaginable tininess of engineering involved. It is a realm of true alchemy, where substances can be reconfigured and shaped at will. Minsky states in his foreword to Drexler's book, "Nanotechnology could have more effect on our material existence than those last two great inventions in that domain—the replacement of sticks and stones by metals and cements and the harnessing of electricity. *Engines of Creation* is the best attempt so far to prepare us to think of what we might become, should we persist in making new technologies."

One handout from the Nanotechnology Study Group foresaw whole computers smaller than a millionth of a meter, going at millions of cycles per second, on billionth-of-a-watt energy, with memory in the trillions of bytes.

Utter plastic, utterly brilliant.

The assembler breakthrough, the enthusiasts proclaim, could come in twenty years, plus or minus ten years. Engines self-assembled from diamond, human immortality, zero pollution, space suits as alive as the wearer but immeasurably tougher and more sensitive—the speculation in *Engines of Creation* is good, heady technological forecasting done with a scientist's training and a science fiction writer's imagination.

Impressively, Drexler doesn't leave it there. The book is warning as well as promise. "All panaceas become poison" is the theme of most science fiction. Too much of anything wonderful becomes terrible. Part of the real research on any new good thing is discovering how much is too much, how fast is too fast.

Artificial intelligence and nanotechnology are not the only potential runaways in progress. The rich human connectivity that the Media Lab is inventing also has harmful excesses waiting to be explored. New technologies create new freedoms and new dependencies. The freedoms are more evident at first. The dependencies may never become evident, which makes them all the worse because then it takes a crisis to discover them. Crises of large complex systems can be nasty if the system hasn't had time to mature a lot of checks and balances.

If there is a single science fiction story most expressive of the future the Media Lab is inventing—of the hazards of totally addictive total connectivity—it is "The Machine Stops" by E. M. Forster. Yes, the one who wrote *A Passage to India* and *A Room With a View*. It was 1909, he was thirty, he was incensed by the optimistic materialism of H. G. Wells's *The Time*

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LIVES OF THE CELL

SPACE

By Alcestis Oberg

Can creatures that evolved on Earth safely lead an extraterrestrial existence? This simple question has a complex and troubling answer especially for life on the most fundamental level the cell.

In space the fundamental cycle of life—birth, growth, reproduction, and death—has been studied on a very small scale in bacteria, complex plants, and animals. Space experiments in developmental biology during the Sixties and Seventies did not turn up the monstrous anomalies that some had feared. Some fish, insects, and amphibians seemed to thrive in space. Scientists rejoiced in the apparent resilience of life.

But experts cautioned that the experiments were few in number and narrow in scope. They pointed out that all the embryos grown in space came from Earth-grown ova and that seeds planted in zero g came from terrestrial plants. It turned out they were right to worry. The bad news first came from plant experiments onboard the shuttle and the Soviets' Salyut space station in the early Eighties. On Salyut a large number of seeds collected from a plant the Russians had coaxed into flowering in space turned out to be sterile and deformed. In one series of U.S. shuttle experiments, space-grown plants showed chromosomal damage. Oats planted on the second shuttle mission suffered from fractured chromosomes, and a batch of sunflowers lost a chromosome completely.

Experiments done aboard the German-sponsored Spacelab D-1 in 1985 raised other questions about the microscopic effects of spaceflight. Studies with insects brought especially disturbing news. Fruit fly eggs that had been both formed and fertilized in space had a high rate of sterility. The unhatched eggs seemed to have stopped growing at an early stage, suggesting either delayed or abnormal development. Embryos of the stick insect *Carausius morosus* also suffered serious damage during their early development in zero g. One half to two thirds of the eggs were unhatched. Of those that did hatch, the offspring had shorter life spans and showed a large amount of genetic damage manifested by deformed abdomens and antennae.

Humans were just as susceptible to the mysterious effects of zero g. Blood samples taken from Russian cosmonauts upon returning from long-duration flights in the early to mid-Eighties had already shown pronounced damage to the lymphocytes, disease-fighting white blood cells. In a Spacelab experiment lymphocytes cultured in vitro reacted negatively to zero gravity. Only 3 percent showed a normal level of cell activity. These cells are key components of the human immune system. The finding suggested that our natural defense against disease and infection could be crippled in space.

Another Spacelab D-1 discovery was that bacteria grew faster in space than on Earth and were more resistant to antibiotics. It appeared that not only was a spacefaring body weaker, its microscopic enemies were stronger as well.

Researchers continue to question the effects of space on living things. Answers may come from a project now on NASA's

Earthly life in space. Will it bloom or die?

drawing board. Called *Lifesat*, this reusable biosatellite would carry animal and plant experiments into orbit and return to Earth on its own.

Scientists in NASA's Life Science Program want to adapt a design for a satellite used by the Air Force in the Sixties to carry surveillance cameras. In those days a satellite was launched into orbit, took its pictures, and dropped back into the earth's atmosphere, where a plane would snag it in mid-fall.

NASA would take the satellite and make it a kind of self-contained, automated minilab that would perform experiments in space and then drop out of Earth orbit on radio command. The module would be equipped with its own power supply, onboard video cameras, recording equipment, and environmental controls. It could stay in orbit up to a month.

Instead of having a plane retrieve the satellite, NASA would install in it a large version of a skydiver's parachute and guide it back to a landing at mission's end. Because of the satellite's small size—20 cubic feet—and its 450-pound payload, it could hitchhike on unmanned Air Force boosters, or it could be squeezed aboard a shuttle flight that did not have a full cargo complement.

Lifesat could be put into Earth orbit as early as 1990. Once the space station is in operation, the satellite could be sent up and attach itself to the outside of the station like a barnacle. More than half of NASA's life-science experiments could be done with one of these low-budget robot labs.

"With *Lifesat* U.S. scientists could launch two or three experiments approximately twice a year," explains Thora Halstead, manager of the Space Biology Program at NASA headquarters and president of the American Society for Gravitational and Space Biology. "It would be a small budget item compared to other NASA projects. And it would give us the chance to do important scientific work in space at low cost."

Still in its early stages, the idea has already received an enthusiastic response. "There's been a huge interest among

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DEATH BY STRESS?

BODY

By Gary Hanauer

Eleven hundred people die from it every day, some expiring within a few minutes of the symptoms first appearance. The victim experiences a drastic and uncontrollable increase in the rhythm of his heartbeat. This condition quickly deteriorates into the lethal state of ventricular fibrillation, during which the heart trembles and jerks instead of pumping blood.

Sudden death syndrome—or sudden cardiac arrest—claims more lives than any other disease: 400,000 annually, according to Dr. Robert Eliot, director of the National Center of Preventive and Stress Medicine in Phoenix. Men fall victim to the syndrome more than twice as often as women. (Researchers believe that women's hormones protect them from sudden death until menopause.)

Now evidence suggests that sudden death may not be so sudden after all. The wildly erratic heart rhythms—or arrhythmias—that characterize the syndrome are thought to be triggered by inappropriate electrical impulses from the brain. Harvard Medical School cardiologist Dr. Bernard Lown believes these impulses are activated by stress.

Stress has long been suspected of contributing to heart disease. Until recently, however, many of the data linking it to fatalities have been anecdotal.

In 1981, for example, Lown interviewed survivors of life-threatening arrhythmias. He found that 21 percent had experienced acute emotional upset during the 24 hours before the irregular heartbeats had begun. In two thirds of these cases, the stressful event occurred less than an hour before the attack.

Eliot has been tracking the stress/death connection since 1968, when he was named a cardiovascular consultant at Cape Kennedy. "NASA officials told me to find out why twenty-eight- to thirty-five-year-old engineers were dropping dead for no apparent reason at two and one half times the sudden death rate for the rest of the state of Florida, which had an older population," he remembers. "The CIA was concerned that these young people were being poisoned."

What Eliot found surprised him. Autopsies showed the victims did not have coronary disease. At the time, however, not only had NASA begun a series of sporadic employee layoffs, but alcoholism, drug abuse, divorce, and suicide rates were also on the rise at the Cape. "I wondered if there might be a relationship among the sudden death and the loss of identity, loss of control of their lives, and lowered self-esteem these young people were suffering," Eliot recalls.

Eliot's first step was to repeat his autopsies of the victims, and this time he found part of the answer he'd been seeking: 90 percent of the engineers had ruptured heart-muscle fibers.

Ten years of animal experimentation followed, and Eliot ultimately proved that excess amounts of adrenaline had caused the physiological changes in the engineers' hearts. Fear or other types of stress can trigger the secretion of extra adrenaline—which, in turn, increases heart rate, heightens blood pressure, and speeds up respiration.

"Within five minutes of our administering large doses of adrenaline to lab animals," Eliot says, "chaotic electrical storms began raging in their hearts. Then the hearts started beating like bags of worms, stopped pumping blood, and gave out."

But do shots of adrenaline cause the same response as adrenaline triggered by stress? Eliot's study failed to demonstrate this. Furthermore, he had not determined whether healthy persons were as affected as cardiac patients.

Dr. Benjamin Natelson, a professor of neurosciences at the New Jersey Medical School in Newark, recently conducted studies to address these questions. "We did experiments with animals that prove that psychological factors increase risk for arrhythmia in those whose hearts are already vulnerable," Natelson says.

His research team administered mild electric shocks—preceded by light signals—to one group of guinea pigs in order to teach them that a signal presaged a shock. A second group of animals received only the light signal. After a week's training all the animals were given digitalis, a powerful cardiac stimulant.

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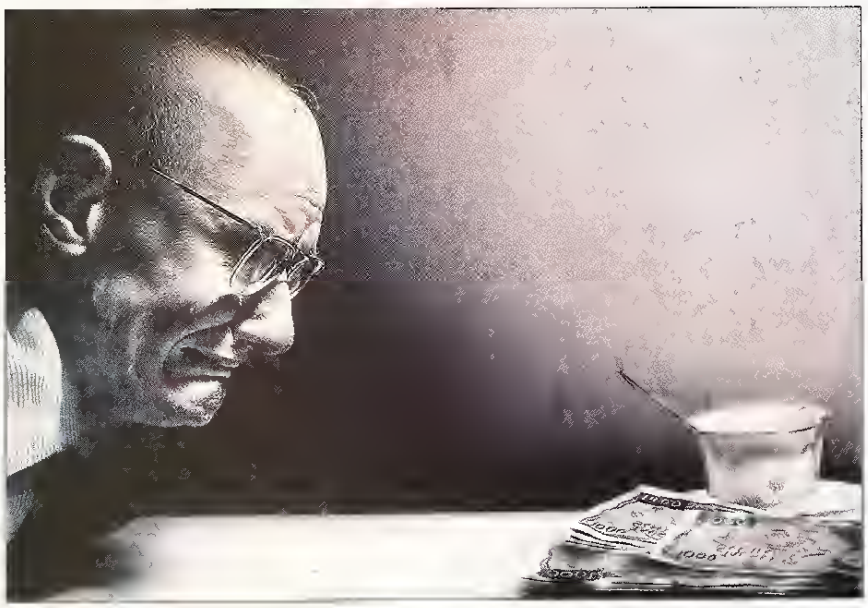


Heart reactors. Some doctors say that stress can trigger cardiac arrest

COSMIC MERGERS

STARS

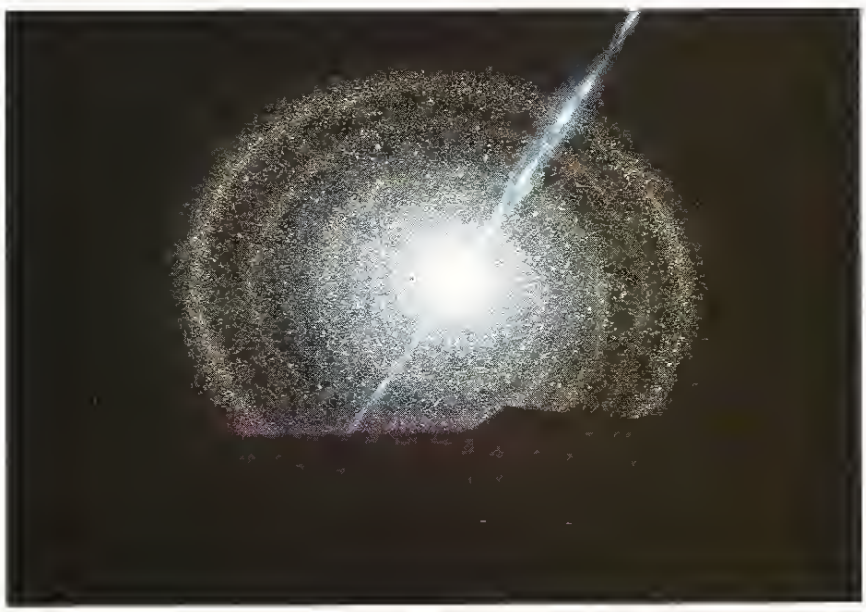
By Steve Nadis

There are eccentrics in every crowd, Alar Toomre points out, even among crowds of galaxies. Most can be readily classified, but a small percentage simply do not conform. For the past 15 years Toomre, a MacArthur Fellowship winner and MIT professor of mathematics, has studied nonconformist star formations: galaxies shaped like rings or spirals, and galaxies with ripples, tails, filaments, or other strange appendages.

Toomre's studies have shown that galaxies are far from being island universes, as was once believed. They interact with their neighbors in a variety of ways—either colliding or merging—causing a wide range of cosmic phenomena. Ridiculed in the early Seventies, this theory of collisions and mergers is now regarded as one of the best descriptions of the evolution of galaxies.

Toomre was first drawn to strange galaxies in the mid-Sixties, when he discovered that our own galaxy is warped. ("One end bends up, the other goes down," he explains.) After a few years of study he speculated that perhaps the distortion was caused by shock waves from a neighbor, such as the Large Magellanic Cloud, flying by. "It would be a transient thing," he says, "like a wave made by a passing ship." If this happened with our galaxy, could it have happened somewhere else? "The answer is yes," says Toomre, "all over the universe." The best evidence he can cite is the *Atlas of Peculiar Galaxies*, which has more than 300 astrophotographs of strangely shaped galaxies collected by Hale Observatory astronomer Halton Arp.

In the early Seventies Toomre teamed up with his brother Juri, an astrophysicist now at the University of Colorado, to explain some of these eccentric cases. Using a computer, the Toomres simulated galactic collisions. "When galaxies collide, it's not like a Volkswagen hitting a Cadillac," Toomre says. "It's more like vacuums colliding." There is a lot of empty space between stars. They don't hit one another, they *pull* like tidal forces. And that pulling dramatically alters the shapes of the galaxies.



A spiral galaxy. When two or more of these collide, the cosmic results can be most peculiar.

Some collisions are glancing, hit-and-run events. But in other instances galaxies circle one another in steadily shrinking orbits until one galaxy falls into a second. The Toomres' simulations showed that gravitational forces exerted during these close encounters could produce a new category of strange galactic structures with designations like "bridges" and "tails."

The Toomre brothers collected their data and explained why certain galaxies—about 10 percent of the total—were blob-shaped "ellipticals." They proposed that the ellipticals resulted from two or more of the more common disc-shaped galaxies crashing into one another.

They published their findings in 1972 in what is now considered a landmark paper. But their thesis was ignored for years. It went against the theory preferred by many astronomers: that all galaxies evolved alone and did so slowly. So the Toomres were alone in their belief.

Then François Schweizer, a young astronomer in graduate school, read the Toomres' paper and found their explanation entirely plausible. "It was the first believable mechanism that showed how strange galaxies might have evolved," he says. When he began his postdoctoral work at the Hale Observatory in 1974, he became obsessed with tracking down examples of galactic mergers.

His obsession has paid off. He has found several hundred good galactic candidates bearing signs of celestial mergers and says there are at least six galaxies that certainly support the Toomres' thesis. The six bear unmistakable signs of mergers. One of the best examples, according to Schweizer, now at the Carnegie Institution, is the elliptical galaxy NGC 7252. It has two long tails, suggesting that two disc galaxies of equal mass collided. Within the galaxy the remnants of the original galaxies form two streams of ionized gas flowing in different directions. "There they are: two surviving motion systems," Schweizer says.

In 1981 Schweizer took the theory a little further. He brought to MIT photos of another unexplained phenomenon: a series of concentric arcs, called ripples,

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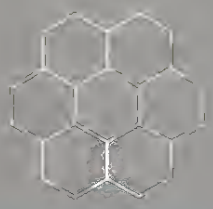


CONTINUUM

THE MATTHEW EFFECT

At a chance encounter before a professional meeting the physicist from MIT told the physicist at Stanford that he was getting weird results from his latest atom-smashing experiments His colleagues had spent months looking for an equipment malfunction that could explain the anomaly they were seeing

Well wasn t that the damnedest thing the Stanford physicist spluttered He and his collaborators had had *exactly* the same experience until just last night when they realized that the quirk in the data was really a new elementary particle

Both groups working independently had accidentally discovered the same subatomic particle It was time to stop talking start writing For in science being the first to *publish* enables scientists to lay rightful claim to their own research findings

The MIT/Stanford affair finished in a rare dead heat Both sides submitted papers to *Physical Review Letters* on the same day and the journal published them simultaneously Within a week of the official announcement of the particle s discovery the journal received four more papers from theoreticians eager to stamp their interpretation on the tiny newcomer

The living literature of science fills upwards of 40 000 journals worldwide with a new article published approximately every 30 seconds Scientific journals however are no mere conduits of information accepting any manuscript that comes along By their editorial policies and their ingrown prejudices they not only document the course of science they determine it Thus the colliding worlds vision of immanuel Velikovsky denied journal publication stands forever outside science Velikovsky may have *printed* his ideas in a popular book but he was never *published*

Observers of the publication process have come up with various laws and formulas that try to describe its behavior Lotka s law for example, is A J Lotka s mathematical expression of scientists publication productivity (More than half of all scientific articles it turns out are written by less than 10 percent of all scientists) The Matthew effect, named by Robert Merton for the biblical Matthew reminds us that the published get published-er (As Matthew wrote 'Everyone that hath shall be given even more) And the Author s formula spelled out satirically by J S Armstrong advises would-be scientist/authors Don t pick an important problem, don t challenge existing beliefs don't obtain surprising results and don t write clearly

Recently there have even been a few attempts to experiment directly on the editors and reviewers who decide which manuscripts will appear in the journals Michael J Mahoney a journal editor himself for six years tried his experiment on 75 reviewers for a well-known psychology journal He gave each reviewer one of five versions of a fictitious but plausible study in child behavior In one version the results supported orthodox behaviorism In another the results contradicted that theory A third version offered no results The two remaining versions presented mixed results with interpretations arguing for or against the theory

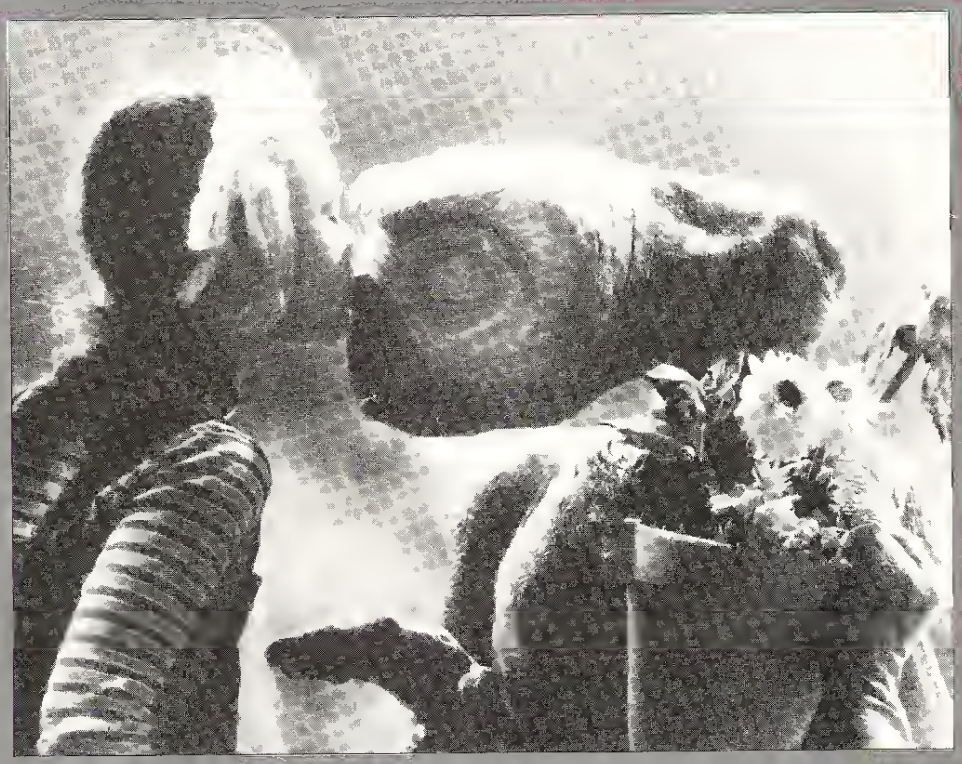
Here s what happened The reviewers who got the positive outcome paper accepted it and called the experimental procedure top drawer The reviewers who got the negative outcome rejected the paper and panned the experimental procedure What's more negative-results reviewers were quick to point out an important numerical typo in the manuscript that most of the positive results reviewers missed Nobody liked mixed results so the no-results reviewers were asked simply to judge the relevance of the study and the experimental procedure They thought both were fine When the reviewers learned what Mahoney had done three participants tried to have him fired or at least reprimanded by the American Psychological Association Mahoney did ultimately succeed in getting this work published

Douglas Peters and Stephen Ceci tried another kind of test on journal reviewers They took 12 articles that had already been published and *resubmitted* them to the 12 journals where they had appeared some two years earlier Only the names were changed The names of the authors and the universities where they taught were changed to make them look a little less prestigious And the titles of the articles were changed to make them look a little less familiar

Only three of the resubmitted articles were recognized as old friends Of the remaining nine eight were rejected The study itself was published but one of the authors was nearly denied tenure because of it

'We can no longer afford to believe that our scientific thinking and behavior occur in some idealized and dispassionate vacuum ' concludes Mahoney 'I recommend that we more openly and actively study our own inquiry processes '—*DAVA SOBEL*

CONTINUUM



Will we ever come face-to-face with real extraterrestrial intelligence? A new computer chip vastly increases the number of microwave channels we can monitor for signs of other civilizations

NEW HOPE FOR SETI

NASA's Search for Extra-terrestrial Intelligence (SETI) is receiving a technological boost from some Stanford University graduate students who have developed a computer chip that vastly increases the number of microwave channels that can be simultaneously monitored for messages.

Currently 72,000 one-hertz channels can be monitored at one time. The new chip will up that number to *10 million*. The system, called a multi-channel spectrum analyzer, can tune in to any of the 10 billion one-hertz-wide channels that make up the microwave spectrum.

SETI efforts are currently centered on 1,000 of the stars most likely to possess a solar system with life. The new system will enable a star to be checked for microwave signals 40 times faster than before. But even with the new system, each star will require the radio astronomers to take 1,000 "steps" across the microwave window to check all 10 billion channels.

Each of these steps can take several minutes or more, so the Stanford group is working on ways to improve their system by factors of ten. "The ten-million-channel machine represents our conservative estimate of what we can do," says Ivan Linscott, senior research associate at Stanford's Space Telecommunication and Radioscience Laboratory. "We would like to see the capability of one hundred million channels."

The first ten-million channel analyzers should reach the field by the fall of 1988, Linscott says. He hopes they will be used by SETI groups around the world.

If someone is calling Earth, the new chip should make it substantially easier for the call to come through.

—Grant Fjermedal

ANCIENT MYSTERY

When Stephen G. Miller, who's been directing excavations at the Temple of Zeus on Greece's Peloponnesian peninsula since 1973, unearthed a 2,400-year-old plaque last year, he became the central figure in an archaeological mystery that may never be solved.

Miller, a classics professor at the University of California, uncovered the marble slab, two and a half feet high and 18 inches wide, in the soil around the foundation of a small house in Nemea. Miller's find is believed to date from about 475 B.C. That means it was carved in the decade that followed Greece's war against the Persian king Xerxes.

The marble depicts a man standing with "what appears to be a rope over one shoulder" before the seated figure of a woman. The carving is a curious mixture of

The Nemean slab. Just who are these two people?

archaic, or pre-Persian War and classical postwar styles

But after the war, marble was not quarried in the Peloponnisos It came from the Aegean or from Athens say the archaeologists How did this particular slab get to Nemea? Who are the figures, and what do they mean? Miller and his associ ates doubt they represent such gods as Zeus Poseidon, Hades or Hera They hope isotopic analysis will help answer some of their questions Their theory is that the figures are King Lykourgos of Nemea and his wife, whose son, mythology says, was killed by a snake

—George Nobbe

'Man is the animal that intends to shoot himself out into interplanetary space, after having given up on the problem of an efficient way to get himself five miles to work and back each day'

—Bill Vaughn

DAYS OF SUNSHINE PAST

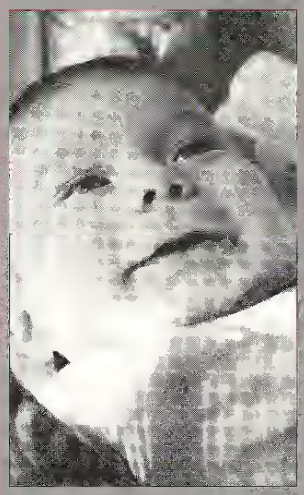
It's not just an old timer's illusion The weather really was nicer in the old days

That's the conclusion reached by William L Seaver of the Virginia Polytechnic Institute in Falls Church and James E Lee of the MITRE Corporation in McLean Virginia The researchers compared the number of cloudy days—or more precisely, the amount of "sky cover,' including clouds, smoke, haze, and so on—in the United States during two periods, 1900–1939 and 1950–1982 They found that the latter half of the century has been 10 percent cloudier than the first half

Computing the number of cloudless days in 45 different U S cities they discovered that only one—Fort Worth—got sunnier In contrast, the number of sunny days in St Louis dropped from 7 2 days per month to 4 7 days, in Los Angeles, from 10 to 7 6, in Washington DC, from 5 3 to 4 4

Why? ' We're not trying to say what s causing it yet,' says Seaver ' Pollution could have something to do with it and overall weather patterns have probably changed Meanwhile, Stanley Chagnon of the University of Illinois at Champaign Urbana speculates that jet contrails may be the culprit And in Michigan Val L Eichenlaub of Western Michigan University in Kalamazoo points the finger at polar weather moving southward

—Luna C Grant



A baby s wet raspberry may be a clue to his intelligence

THE NEUROBIOLOGY OF GOO-GOO

You may not understand what Baby Jimmy means when he asserts 'Bababa-bab-b-b-b ' but Dr Arnold J Capute does

According to Dr Capute a professor of pediatrics at Johns Hopkins Medical Center infantile coos babbles Bronx cheers, and 'dadas' are the best predictors of intelligence—far more accurate than motor milestones like crawling and walking But present tests of infant development focus mainly on visuo-spatial skills, eye–hand coordination, and so on So Capute and his colleagues have devised the first standardized infant language test called CLAMS (Clinical Linguistic and Auditory Milestone Scale)

CLAMS was developed by interviewing the parents of about 400 children at frequent intervals from the age of two weeks to 24 months When CLAMS scores were compared with the children s I Q s at age three the researchers found a striking correlation thanks to questions such as When did your baby first produce vowel sounds in a musical fashion?

Early milestones include the first social smile (four to six weeks) the first dovelike cooing (six weeks) the first "wet raspberry (four to five months) the first babbling with consonants (six to seven months) and the first meaningful dada (nine months)

Ten fifteen years ago, people thought language developed in a haphazard fashion says Capute 'If you said Goo-goo to your baby they thought you could teach him or her to do it at two weeks That s not true The ability to say Goo-goo depends on neurological development

—Judith Hooper

Yes sunny days are getting harder [illegible] latter half of the century has been 10 percent cloudier than the first half

CONTINUUM

A bean-rust fungus attacks the pores of a simulated leaf

NANOSTUFF

It used to be called the Submicron Lab but now Cornell University's kingdom of the minuscule has a new name the National Nanofabrication Facility That's because the physical, electronic and biological objects built here are no longer merely in the submicron realm (a micron is a millionth of a meter) Some of them now measure 25 nanometers—that's 25 *billionths* of a meter, or 2 000 times smaller than the width of a human hair

What are these weird, Lilliputian devices anyway? Well, you need an electron microscope to see them, of course The tiniest things, with dimensions of one or two nanometers are built merely to probe the outer limits of smallness according to Greg Galvin deputy director of the lab In creations as small as ten nanometers, physicists study the flow of electrical current and various quantum events Microelectronic components—such as the individual gates in a transistor—have been miniaturized to sizes of 50 to 100 nanometers

Twenty-five nanometers also happens to be the scale of many biological molecules so biomedical nanofabricators will be able to make models of such phenomena as antibody–antigen recognition says Galvin In the plant realm the lab has been able to simulate a leaf's breathing pore which was then attacked by a real fungus —Judith Hooper

'He was a wise man who invented God"

—Plato

"Each one of us is a statistical impossibility around which hover a million other lives that were never destined to be born

—Loren Eiseley

GREEN ANTARCTICA

Most of us think of Antarctica as a Dantean wasteland locked—past present and future—in the frozen white grip of perpetual polar winter Until recently geologists have held much the same view But new findings indicate that Antarctica has gone through periods during which it was warm enough to actually turn green

Camped out for six weeks in the highlands of the Transantarctic mountain range, a team led by Peter Webb of Ohio State University found 2-million- to 3-million-year-old fossils of trees plants, pollens, and spores

The evidence has led Webb to paint a new, revised picture of an Antarctica that went through periodic cycles of dramatic warming During those epochs he says Antarctica may have looked much like the hardy low-lying forests currently found in southern Chile New Zealand and Tasmania where dwarf shrubs and small beeches—'They look a little like bonsai trees he says—cling to rocks and point perpetually in the direction of the strong prevailing winds Interestingly Webb has recently seen reports indicating that some of the same fossils have been found in the Arctic Periodic warming he concludes may be a bipolar phenomenon It's impressive that similar species developed at both ends of the earth —Bill Lawren

Antarctica Has it always been locked in the grip of perpetual winter? A new theory holds it once supported a low lying forest

'If I had been present at creation, I would have given some useful hints

—Alfonso the Wise

HAPPY CHICKENS

What makes a chicken happy? I don't know admits Ari van Tienhoven an animal physiologist at Cornell University whose current research focuses on just this topic Yet it happens that Van Tienhoven does know a few things about fowl happiness and malaise

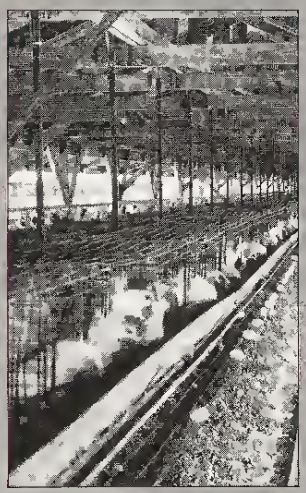
If you're talking about individual chickens egg production turns out to be a better indicator of happiness than things like hormones Van Tienhoven says High levels of corticosteroid hormones have been considered a measure of stress But you have to assume that the chickens at the bottom of the pecking order would be the most stressed and they do *not* have higher corticosteroid levels They do lay fewer eggs '

You may not be overly

interested in the psychological state of future Perdue oven stuffers but poultry farmers certainly are And so are some befrienders of chickens The animal welfare people—they re not called that but you know what I mean—say that chickens should not be in cages that they should be on the range ' says Van Tienhoven "But on the range rats go after them, their intestines get full of worms, their combs may freeze—which is very painful—and some starve Is that happiness?'

In fact Van Tienhoven has compared the general welfare of birds in cages with that of birds roaming freely on the pen floor He says, The ones on the floor had worms in their intestines and some of them starved Of course birds in cages *look* miserable Their feathers break—they look like worn fur coats '

—Judith Hooper



What came first A happy chicken or the eggs?

Will a convict's eligibility for parole one day depend on the contents of his drool? A new Georgia State University study links violence to high levels of testosterone in the saliva of inmates

SALIVA PAROLE TEST

Currently parole boards look at a prisoner s personal background criminal record and behavior in confinement before deciding if a convict should be released early But one day they may also study what's in an inmate s saliva before placing him on parole

That s a possibility being considered by the Georgia Board of Pardons and Paroles, based on research by Georgia State University psychologist James Dabbs that links high levels of testosterone in saliva to violence

Dabbs studied 200 inmates in Georgia prisons and found high levels of the male sex hormone among convicts with records of violent crimes Women have only about 10 percent the amount of testosterone found in men Dabbs notes but females convicted of unprovoked violent crimes also frequently had elevated testosterone levels

Dabbs emphasizes that s not proof that a high level of the hormone *causes* violence Elevated testosterone has also been linked with social appeal and positive behaviors So there may be other physiological factors that work with testosterone to create a violent criminal Although saliva tests could be done easily in jails Dabbs won t predict if testosterone measurement will ever be used to decide if a prisoner is a safe parole risk But I won t be surprised if aspects of biochemistry are eventually incorporated into parole policy

Wayne Snow chairman of the Georgia parole board agrees If this test holds up as a good predictor I can foresee us adding it to the other factors we consider—like marital status psychiatric history education and criminal record—when we determine parole

—Sherry Baker

CONTINUUM

MIGRATORY MYSTERY

Why are Canada geese now migrating to Chesapeake Bay instead of to their traditional winter resorts in North and South Carolina?

'The birds are breaking tradition and we don't have a good handle on that yet," says Richard A. Malecki of Cornell University, who with his colleagues has banded some 25,000 geese and logged some 100,000 observations to unravel this migratory conundrum.

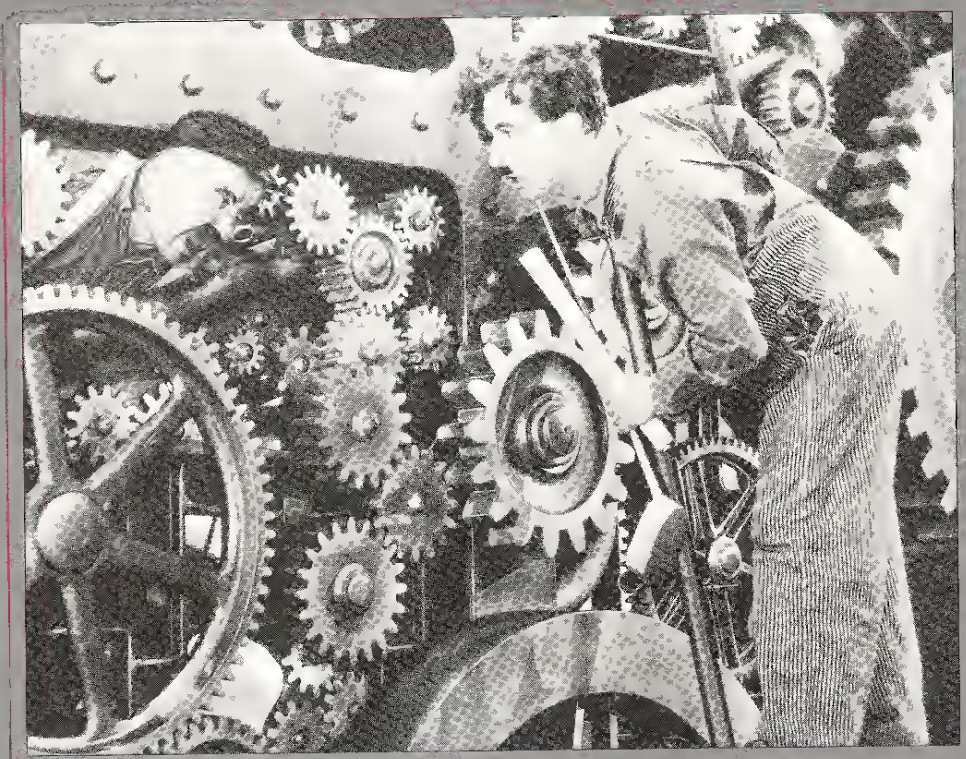
'Some birds still fly to the Carolinas, but the majority are nesting in the Chesapeake Bay area,' Malecki says. "We've even seen a new tradition here in the Finger Lakes region [in New York State]. Some twenty thousand or thirty thousand Canada geese winter here."

Although his study is ongoing, Malecki has some preliminary theories. A long trek south probably puts the geese in the path of more hunters, as the birds that fly to the Carolinas have lower survival rates. At the same time, agricultural changes in the Chesapeake Bay area and other parts of the North are good news for geese. "There's a lot of corn and soybeans planted, which means the birds have high-energy sources to withstand lower temperatures. They can meet their winter requirements without going south.

'What we don't know yet is what will happen when there's a severe winter in the North. Will the geese go south or try to weather it?"

—G. X. Bear

Canada geese. Why are they vacationing so far north?



Factory workers have been intimidated by automation since the early days of the century. Now, from Europe, good news: People are being put back in charge of computers that run assembly plants.

HUMANS MAKE A COMEBACK

For years the eyes of American industrialists have been alight with a vision of the factory of the future: a totally automated plant in which human beings have been replaced. But in Europe there's a growing trend embodied by the Common Market's Esprit Project 1217 to put the human beings back in charge.

Computerized manufacturing, explains Mike Cooley, technology director of the Greater London Enterprise Board, has traditionally been seen as more efficient, less expensive and less unpredictable than the human-run variety. But in fact, Cooley says, fully computerized systems tend to be 'brittle and inflexible—they lack intuition, judgment and imagination—so that when one part of the system goes down, the rest goes down with it. Humans, on the other hand, have an extraordinary ability to handle uncertainty and thus to react quickly to unforeseen problems.

Project 1217—a cooperative effort with branches in Britain, Germany, and Denmark—will bring experienced workers back to the factory floor, give them

computer training, and then put them in charge of programming and operating the computers that run assembly processes. Rolls Royce will provide a prototype factory in Leavesdon, and Cooley hopes to have that factory turning out machine tools by October 1988. —Bill Lawren

"Our dreams are our only real life."

—Federico Fellini

"Technology was developed to prevent exhausting labor. It is now dedicated to trivial conveniences."

—B. F. Skinner

SOBER-UP PILL

The laboratory rat lies on its back, so drunk it can't roll over. But within minutes of receiving a chemical called Ro 15-4513, the animal rights itself and appears normal and alert. According to National Institute of Mental Health (NIMH) researcher Peter Suzdak, chronic human alcoholics may one day experience similar results from the sobering drug.

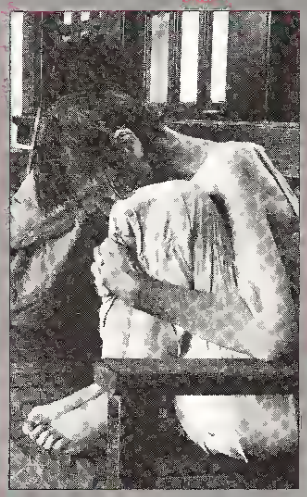
"It appears to block the antianxiety and euphoric feelings of alcohol effects that are mediated through the inhibitory neurotransmitter GABA," Suzdak explains. "If an alcoholic taking Ro 15-4513 no longer got a high, he could lose his reason to drink."

NIMH scientists are currently testing the drug on monkeys. Suzdak expects human trials to follow in a couple of years. "We want to develop an analog of the drug that has a half-life as long as that of alcohol. Eventually, I think it will be used to treat alcoholics."

But Suzdak doubts a sober-up pill will ever become available. "That might encourage people to drink, and we aren't advocating that."

—Sherry Baker

The sober-up pill is not as good as it sounds. Its main job is to block the antianxiety and euphoric effects of alcohol.



Schizophrenic. Dopamine may be the culprit after all.

SCHIZOPHRENIC BRAINS

Medieval doctors believed that demons inhabited the heads of the mentally ill. Now scientists at Johns Hopkins University have turned up something much more tangible in the brains of schizophrenics.

A team led by nuclear medicine specialist Dean Wong, M.D., used positron emission tomography (PET) to measure the receptors, or target sites, for the chemical messenger dopamine in the brains of schizophrenics and of normal controls and discovered that the schizophrenics had twice as many dopamine receptors.

Dopamine—specifically, too much dopamine—has long been suspected in schizophrenia, as antipsychotic drugs block this chemical. In the past, autopsy studies have shown an abnormally high number of dopamine receptors in schizophrenics' brains, but it was unclear whether this was due to the disease or to the drug treatments. Fortunately, 10 of the 15 schizophrenics in the Johns Hopkins study were among those rare birds who have never received antipsychotic medication. ("We received referrals from all over the country," Wong explains. "One of the cases was a doctor's son who had never received any treatment other than psychotherapy.")

The new technique, pioneered on a human being just four years ago, consists of injecting the patient with a radioactive form of an antipsychotic drug, which binds to the brain's dopamine receptors. Then the receptors are "photographed" with a PET scanner.

"Previously," notes Wong, "when you wanted to know whether a particular drug was working, you'd ask the patient, 'Do you still think radio waves are entering your head?' But with this technique you can see how well the drug is blockading the receptors. If there's a twenty-percent blockade, you might increase the dosage. If there's a hundred-percent blockade but the patient isn't responding, you might switch to a different medication. You should be better able to control the side effects, too." —Judith Hooper

"Like many important scientific discoveries, LSD was the result of equal quantities of painstaking, tedious research and luck."

—Eugene Schonfeld

CONTINUUM

THE DIGITAL BEE

Riddle How is a honeybee like a computer?

Answer It's not But a whole hive of bees has a lot to teach researchers in artificial intelligence according to Cornell University biologist Thomas Seeley

Actually there are three things that are similar the brain parallel computers and insect societies," he says 'In each system the individual parts are relatively simple The whole is greater than the sum of its parts because of the interaction among the parts Consider the collection of pollen 'An individual bee can go to only one place at a time but a colony of thirty thousand bees acts like a cognitive entity Seeley notes It can have hundreds of bees searching simultaneously for patches of flowers Yet there's no leader that issues orders Instead bees communicate information about pollen and other vital matters with a dance language

The lesson here is decentralized control and division of labor Tomorrow's supercomputers will consist of many processors working in parallel just as bees do The individual processors won't be all wired together but rather, will exchange messages at a central 'billboard"—analogous to the bees shared environment And while most parallel designs are based on linking many many simple units Seeley instead envisions a smaller number of more complex processors—something like 50 000 linked

Hu[illegible]arch simultaneously for flowers yet there s no lead[illegible]rders A good lesson for computer makers

Macin[illegible]puters

An i[illegible]bee is not at all stup[illegible]rves Each b[illegible]e actually a very complicated computer'

—Judith Hooper

FUTURE MAN

A Virginia forensic scientist basing his admittedly speculative projections on evolutionary trends that date back to australopithecine man has come up with a description of what we all may look like 50 000 years from now It is not an attractive picture according to Thomas E W Goyne of the Virginia Department of General Services who predicts that we will be shorter and more compact with receding hairlines finer hair and more gracile hands feet arms and legs Despite smaller skulls brain size will remain the same so we'll all have bulging foreheads

'I don't have any crystal ball," admits Goyne, who nonetheless says that 'If three million years of fossil records are accurate bigger won't be better Smaller will take up less food and space We will look [to humans in the year 51 987] about as primitively deformed as Neanderthals now look to us'

We will have corn silk hair he suggests and we'll be exceedingly clean despite a shortage of water We'll live in domed cities with controlled atmospheres wear ripstop nylon clothes and dine largely on dehydrated vegetables fruit and poultry as well as such tasty ocean foods as algae

The state will probably manage all arable land, so rural society as we now know it will have disappeared Our roads will be flat and straight—geared to tracked vehicles—and the emphasis will be on efficiency and productivity Society won't tolerate anything else predicts Goyne simply because it won't be able to afford it

Oh yes along those lines the workweek will be much longer —George Nobbe

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God lives in a box all week and comes out on Sunday in funny clothes to talk about money

—Sean Michaels live

'I know the answer! The answer lies within the heart of all mankind! The answer is twelve? I think I m in the wrong building

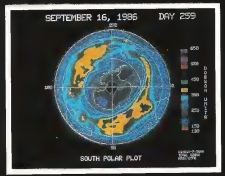
—Charles Schulz

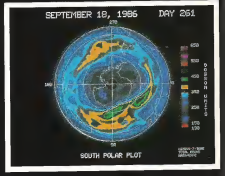
It would indeed be a tragedy if the history of the human race proved to be nothing more than the story of an ape playing with a box of matches on a petrol dump

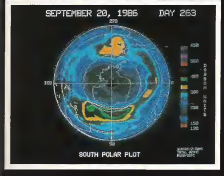
—David Ormsby Gore

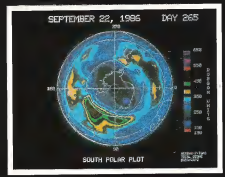
' 'Tis with our judgments as our watches none goes alike yet each believes his own'

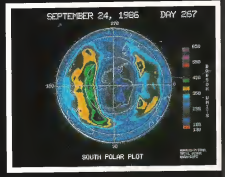
—Alexander Pope

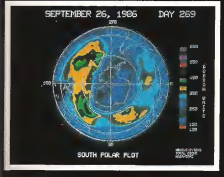


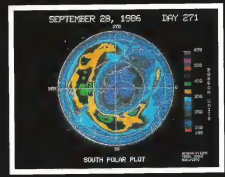


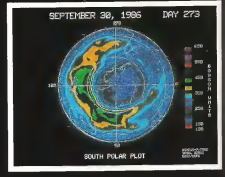


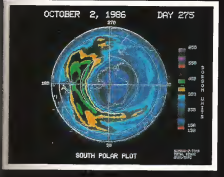












ARTICLE

An intrepid group of pilots will pierce the heart of the Antarctic vortex and solve the mystery of the ozone hole when they

WATCH THIS SPACE

ELLEN RUPPEL SHELL

On the ground the world's only ER 2 has all the grace and speed of a dodo bird. The mammoth wings of this beast rest on a pair of crutches called pogos, which fall off automatically when the plane somehow manages to lift off. Its fuselage, crammed with switches and dials, is the width of a well-toned human body—a fat man might be able to squeeze behind the steering wheel, but he'd probably wish that he hadn't. Jutting up from the floor, between where your knees might be, there's a red box. Jim Barrilleaux describes what's inside. "That's the ejector seat trigger," he says. "I'd say about one guy trips the thing every year on one plane or another. Blows him self right through the roof."

Barrilleaux has never experienced that sensation, but he's had his share of memorable moments. As a former fighter pilot and Vietnam veteran, he knows what it's like to be afraid. His office walls are cluttered with citations for leadership and bravery. His nickname, which he refuses to discuss, is Captain America. He is one of only six men in America, all based at NASA's Ames Research Center in Mountain View, California, qualified to pilot the ER 2.

Barrilleaux and his colleagues feel more at ease stuffed in tight rubber suits while flying solo 60,000 feet above the earth than they do behind desks. Danger is their antidote for boredom. Even so, these hard-hewed pilots aren't entirely pleased with the latest scheme NASA scientists have cooked up for them—flying into the heart of the Antarctic vortex, a tightly coiled helix of

Generated by the Nimbus 7 total ozone mapping spectrometer, the pictures at left show the Southern Hemisphere ozone hole expanding over a period of time from September 16 to October 2, 1986

"The Antarctic stratosphere loses half its ozone every September. An equally sharp decline above New York would make sunbathing a death-defying act."

air cut off from the rest of the atmosphere by a furious whirlpool of wind. If the plane starts to choke and the pilot pulls the trigger between his knees, he's signing his death warrant. There's no room in the ejector seat for cold-weather gear, and after a several-minute descent through the coldest spot in the atmosphere, he'd greet the Antarctic sea or ice with nothing but a suit of nylon, rubber, and mesh—about as useful as a bikini against the polar winds and cold. The pilots have advised NASA not to waste money on a search-and-rescue mission in Antarctica—they figure they'd freeze to death before the rescue team got to them. They are, they say, flying this one without a net. "I'm not telling my family what this mission is about until it's over," Barrilleaux says. "But I am willing to fly it because I am convinced this flight could have a global impact."

The purpose of the mission is to find out why the roof of the world has sprung a leak. The mysterious hole, discovered barely two years ago, is in the ozone shield—a sparse layer of deep-blue gas cast into the stratosphere, the upper region of the atmosphere. Ozone is the only thing protecting Earth from the scathing ultraviolet (UV) rays of the sun. Without the ozone shield, Earth dwellers stand about as much chance of survival as lobsters at a clambake. "Without ozone," says Brian Toon, an associate fellow at the National Oceanic and Atmospheric Administration (NOAA), "we'd all have to go back to living under the water." That's why the discovery that the Antarctic stratosphere loses about half of its ozone every September is so frightening. An equally sharp decline in ozone in the stratosphere above, say, New York City would cause skin cancer rates to skyrocket and make sunbathing a death-defying act. Our immune systems would falter, leaving us vulnerable to disease.

What's more, a radical loss of ozone might possibly render the world uninhabitable. The stratosphere could heat up by as much as 40° F, warming air close to the earth by about 4° and melting the polar ice caps. Sea levels would rise and submerge many coastal cities. Rainfall patterns could change radically, flooding the deserts and turning the north central United States into a dust bowl. The corn belt would become the bikini belt but without the cooling ocean breezes. None of these scenarios are certainties. But it is clear that if the Antarctic hole harbingers things to come, life on Earth will never be the same.

Enter Barrilleaux. Come late summer and early fall (providing the weather holds up), he and several other ER pilots will embark on a journey into the ozone hole, going up on 12 flights over a two-and-a-half-month period. For several hours on each trip, they will take samples of the hole, gathering data to help experts on the ground determine how much ozone has vanished and what chemical process is involved.

The first clue that something was amiss in the stratosphere came in the early Seventies, after British biospheric chemist James E. Lovelock did an analysis of the atmosphere over the Irish Sea. A gentle, soft-spoken man with a polite disdain for convention, Lovelock is best known as father of the Gaia hypothesis, the concept that the planet Earth is a living, breathing organism, with a life-force—and perhaps even an intelligence—of its own. Though he holds a Ph.D. in medicine and was a researcher at the British National Institute of Medical Research for 20 years, Lovelock considers himself a freelancer, working out of a garage laboratory at his home in the rural English village of Bowerchalke. There he first took measurements using an electronic capture detector, a device of his own invention designed for precise chemical analysis. He found, among other things, tiny amounts of chlorofluorocarbons, or CFCs, chemicals now used in aerosol sprays, foam insulation, and the manufacture of microchips, air conditioners, and fast-food containers. Lovelock was not concerned by this finding. He knew, after all, that CFCs were used in many products precisely because they were inert. Neither toxic nor flammable, they break down only with massive infusions of energy. Because the ozone layer itself prevented potent UV rays from breaking down CFCs in the lower atmosphere, Lovelock concluded that the chemicals constituted "no conceivable hazard."

While Lovelock clung to the notion that a living, breathing Earth could simply *absorb* the oeuvre of man, others, including F. Sherwood Rowland and Mario Molina, did not.

Neither of these men was an insider in the rather insular community of atmospheric sciences. Rowland, a University of California at Berkeley specialist in the chemistry of radioactive isotopes, was scouting around for some new problems to solve when he learned of Lovelock's findings; he was immediately drawn into the problem of finding where all the CFCs went once they entered the atmosphere. Molina, a chemist, had joined Rowland's team as a post-doctoral research associate in 1973 and was equally intrigued.

It soon became clear that CFCs had nowhere to go but up. This confirmed Lovelock's estimate that all CFCs ever produced were still floating through the atmosphere. But the researchers, with their special background in chemistry, realized something else. Far from being a saving grace, the molecules' uncanny stability was probably endangering us all. CFCs were *so* stable that they floated, unimpeded, through the troposphere (the layer of atmosphere

Above: To study the stratosphere above the frigid continent of Antarctica, scientists must brave blustering snow and 40-mile-per-hour winds.

[illegible] to Earth) and into the ozone layer. The CFCs are then exposed to powerful ultraviolet rays, which zapped them into their constituent components of carbon, fluorine, and chlorine.

To Rowland and Molina, what exactly happened to all that chlorine remained the burning question. They generated a complex series of chemical equations, which helped them compute the activity of chlorine given the precise structure of the biosphere. And what they found was terrifying. According to their calculations, the released chlorine was triggering a chain reaction that began with the formation of chlorine monoxide and ended with 100,000 ozone molecules breaking down into an impotent pile of oxygen. Put simply, chlorine was chewing through ozone the way a hungry dog goes through hamburger.

After further calculations, Rowland and Molina predicted that if CFC production and emission continued unabated, stratospheric ozone at an altitude of 25 miles would decline by as much as 50 percent by the year 2050, releasing a potentially lethal dose of ultraviolet radiation into the troposphere. The two scientists went on a campaign to let the world know of their findings. They wrote papers and gave talks outlining the potential dangers of increased UV radiation on Earth—a long list that included an epidemic of skin cancer, genetic mutation, crop damage, and weather changes. Other scientists confirmed their calculations, and the National Academy of Sciences appointed a five-person committee to look in detail at the problem. Environmental groups jumped into the fray, and the National Resources Defense Council, one of the most influential environmental organizations in the country, demanded an immediate ban on the use of CFCs in spray cans. Word of the ozone layer's precarious state trickled down to the general public via people like country music songwriter Sam Adams. The lyrics of his 1974 tune "Aerosols" couldn't have been more explicit:

'Oh, gee! Oh, gee! Let's keep the O_3 / For it shields the ultraviolet from our skin / If you have to spray your hair, leave this Earth,/And go somewhere,/'Cause it's known the ozone layer's getting thin."

But industry remained unmoved. Spokesmen for the Du Pont company, the world's largest CFC manufacturer, pointed out that Rowland and Molina's calculations were purely theoretical, that nothing had been proved, and that they were not about to set back a multibillion-dollar industry until there was absolute proof that CFCs were in fact capable of eating up more than a negligible chunk of the stratosphere. To industry it seemed inconceivable that a chemical used with safety on Earth could pose a danger from space.

But images of the human race vaporizing itself in a spray of underarm deodorant were too strong for most Americans to take, and in 1978 the Environmental Protection Agency and the Food and Drug Administration banned CFCs for use in aerosol sprays. Since then public pressure has all but ceased—most people assume that spray cans are the heart of the CFC industry and that the chemicals are no longer in widespread use.

That confidence, though, was undeserved. First of all, use of CFCs in aerosols had been banned only in the United States, Canada, Sweden, Norway, and Denmark. Throughout the rest of the world, including Japan and the highly industrialized nations of Europe, CFC-laden aerosols were still being produced. And during the Eighties, unknown to most consumers, CFCs were widely used in the manufacture of fast-food containers, computer chips, and a number of other products.

NOTHING ATTRACTS LIKE THE IMP

CORIANDER SEEDS FROM MOROCCO · ANGELICA ROOT FROM SAXONY · JUNIPER BERRIES FROM ITALY · CASSIA BARK FROM INDOCHINA

Specialists cognizant of these facts tended to push worries aside. Their reason, a number of studies sponsored by the National Academy of Sciences, which concluded that Rowland and Molina's predictions were vastly overstated. The experts agreed that ozone would eventually be damaged by CFCs but at a much slower rate than originally thought.

Then an obscure group of scientists working for the British Antarctic Survey stumbled upon the ozone hole. Joseph Farman, leader of the group, is a tall, slim man with an unruly shock of graying hair and a tendency to punctuate conversations with self-deprecating chuckles. An exceedingly careful and cautious scientist, he prefers to let his findings speak for themselves. Since 1957 Farman and his team have been monitoring ozone levels from instruments based at Halley Bay, a lonely scientific outpost on the Antarctic coast. Farman tracks ozone levels at Halley Bay with a Dobson spectrophotometer, a device that uses a quartz prism to split light from the sun into its various wavelengths. Wavelengths that strongly absorb ozone are compared with those that don't, and the resulting ratio indicates the quantity of ozone in a vertical column from the earth far into the stratosphere. Farman had noticed a sharp decrease in column ozone levels every September and October, starting in 1977, but for a long time he refused to believe what he was seeing. The stratosphere above the South Pole is usually rich in ozone, and the drop was so dramatic—greater than 40 percent—that Farman at first ascribed his findings to instrument or human error. But when the readings continued to be low year after year, he felt obliged to get the word out.

"We were frankly baffled," Farman says. "It was perfectly clear that what we had found contradicted all the existing [mathematical] models of stratospheric ozone depletion." The models had predicted some future depletion in ozone due to industrial chemicals, but none had anticipated the enormous drop recorded over Antarctica. Nor had America's *Nimbus 7* satellite—specifically designed by scientists at NASA's Goddard Space Flight Center in Greenbelt, Maryland, to monitor ozone levels—detected the hole. Farman believed, however, that even if eventually proved wrong, it was absolutely essential that he report his findings.

In November 1984 Farman submitted a paper detailing his incredible data to the British journal *Nature*. Susan Solomon, a chemist with NOAA's Aeronomy Laboratory in Boulder, remembers reading his report for prepublication review. "I thought, *This is probably one of the most important things that's ever been seen in the stratosphere, if it's right*," Solomon recalls. "It was the monitoring scoop of the century. Other scientists asked me, 'How can you allow something like that to go into print?' Since I couldn't refute it based on hard scientific argument, I had no choice. The atmosphere is filled with surprises. You have to keep an open mind."

Farman's paper, published in May 1985, galvanized the tight-knit atmospheric science community. Goddard scientists, caught, as one scientist put it, with their pants down, scurried to recheck their data. To their extreme embarrassment they found that they had purposely programmed their computers to reject as errors satellite reports of very low ozone levels—the very levels that Farman had found using standard spectroscopy techniques at Halley Bay. Goddard scientists carefully combed through six years of records and not only confirmed Farman's findings but found that the extent of the ozone hole was even larger than he could have dreamed. The de-

pleted slab of Antarctic stratosphere was the size of the continental United States Scientists all over the country scrambled to find an explanation The question of most immediate concern—whether the hole would spread to other parts of the stratosphere—could not be answered until scientists understood just what had caused the Antarctic ozone hole

One of the most interesting theories came from Harvard's Michael McElroy, who had been at the forefront of ozone research for a decade He suggested that bromine, a chemical used in fire extinguishers, among other things, might catalyze the breakdown of ozone by chlorine above Antarctica He also suggested that aerosol particles, such as those thrown up by the eruption of the Mexican volcano El Chicon in 1982, could serve as tiny breeding grounds to speed up the reactions

Solomon also had an idea, one that explained why the hole appeared over Antarctica as opposed to over the industrialized West The Antarctic stratosphere, she pointed out, is unique for its profusion of polar stratospheric clouds, pink-and-green brushstrokes of condensed vapor that pretty up the clear South Polar sky These polar stratospheric clouds, which are common only in the frigid zone of Antarctica, might, Solomon suggested, serve as a template that would speed up the breakdown of ozone by chlorine, thereby resulting in the rapid disintegration of the Antarctic ozone layer during the spring

Both McElroy and Solomon cautioned that while their theories were physically possible, they needed more data before anything could be proved The only way to get those data was to go to Antarctica and take a firsthand look

So, in August 1986, an emergency crew was dispatched to McMurdo Station, a scientific base on the Antarctic coast Solomon was selected to lead

Susan Solomon is an energetic woman of thirty-two, with long black hair parted in the middle, Sixties style, and an assertive manner that can be intimidating Considered one of the most promising young scientists in her field, she was nonetheless surprised to be selected as leader of a team of equally tough-minded senior scientists working in one of the most remote and hostile environments in the world

Going to the South Pole in the winter should be no one's idea of fun The mission's first attempt to fly from New Zealand into McMurdo Station was abandoned when some of the plane's components iced up After they finally arrived, they spent the next two and a half months in a race against frostbite It is so cold at McMurdo in August—30° F below zero is standard—that to go without gloves to adjust an instrument or jot a note is to risk losing the use of your hand forever It is so cramped and isolated that a disagreement can quickly erupt into a feud

But Solomon found the experience exhilarating "McMurdo is all rolling mountains covered with a fantastic white glaze," she says "I'd never seen such pretty sunsets or sunrises as I did while I was there It's a starkly beautiful, untouched environment There's nothing but you and it"

Not that Solomon had much time for sight-seeing The team had a pressing goal to sort through the chemical soup of the Antarctic stratosphere determining how ozone might be depleted and seeing what, if any, role CFCs played in the depletion

This is no mean feat The stratosphere is so thin that a molecule—any molecule—is hard to find, and the identifying reactions occur with such stealth that isolating and measuring any particular compound is like tracking a bead of sweat flicked into a waterfall But Solomon's instruments were precise Working with her assistants, she perched on a roof and maneuvered a mirror to reflect sunlight (and moonlight) through a hole and onto a spectrometer housed inside the building beneath The spectrometer identified the chemical species each wave of light had encountered on its journey from the sun Analyzing her data, Solomon came to the shocking conclusion that the hole contained 20 to 50 times more chlorine dioxide than is normally expected in the stratosphere It didn't *prove* that chlorine from CFCs was eating ozone But it was powerfully suggestive Where else, after all, could all the chlorine possibly be coming from?

Solomon's findings were bolstered by the work of David Hofmann, a University of Wyoming physicist who took ozone measurements at various altitudes with the help of huge, transparent, helium-filled hot-air balloons In sunglasses, woodsman's beard, bright white Mickey Mouse boots, and puffy orange parka, Hofmann looked like a crazed hippie at some surrealistic amusement park Working with four assistants, he managed to wrestle balloon after balloon, each packed with thousands of dollars' worth of sensitive equipment Once launched, the balloons took two hours to reach the appropriate altitude and another half hour to return to Earth Two balloons were lost, and there were several equipment failures But by working 18-hour days—and nights—Hofmann's team finally found what they were looking for the exact altitude of the ozone hole

"The ozone layer is twelve to twenty kilometers above Antarctica and about the thickness of Mount Everest Hofmann now says "We confirmed that ozone in the region dropped precipitously—from relatively high levels in late August to about half of normal levels by the end of September at the start of South Polar spring"

He also gathered evidence in support of Solomon's cloud theory The hole, he learned, was far from homogeneous Some areas within it were ozone depleted by as much as 90 percent, others showed hardly any loss at all This finding makes sense if the greatest ozone declines occur in re-

CONTINUED ON PAGE 80

FICTION

One with simple tastes, the other exotic, these star-crossed lovers have astronomical problems

STARDUST

BY HARVEY JACOBS

Herman Herman lived the schizophrenic life of an artist in America and found a kind of contentment. Compromise was his cocoon. For ten months of the year Herman illustrated annual reports, catalogs, advertisements, slicks for industrial shows. He created covers for paperback romances. This allowed him to live modestly in a small Brooklyn brownstone and hoard a few dollars. Then, for two months, he could do what he wanted to do.

What he wanted to do was to paint skyscapes. In late August he began to pack paints, pads, charcoal sticks, and canvas. He carefully oiled the bearings and cleaned the delicate lens of his Heidelman telescope. It was a beautiful instrument, a wand on a pedestal. The pedestal plugged into standard house current and turned the Heidelman with the precise rhythm of the stars. The scope magnified to four hundred times. That was enough vision for Herman. Flecks of light turned to peas and pearls.

The last day of September he drove a rented car to a rented

beach house on Shell Island, Long Island—a dot of protected land near the Hamptons where the North Shore and the South Shore split and form a crotch. Shell Island rests in the crotch, shaped more like a fig leaf than a gimbal.

After Labor Day the island was all but deserted and a splendid nature observatory. Crisp, thin autumn air did wonders for light. The sun made changing trees glow. The moon was a polished silver disc. Most important, all of the three thousand stars visible to the human eye sparkled in a vast dome of black sky. Ancient light fell on Shell Island, uninhibited by city mists and miasmas.

It was the stars' abstraction that Herman enjoyed. The fact that the heavens moved to a rigid code bothered him a little, but there was mystery enough even in that. Stars, planets, moons, comets weren't a bunch of Germans going to work on time. They were celestial bodies, things hanging in space, moving like mobiles. Precision is not always the enemy of romance. As a boy Herman himself had fallen in love with a particular Rockette in the line at Radio City Music Hall. She went with the rest, but her movements were surrounded by silence. If the stars were making pictures, Herman was determined to see them first and paint them with his own brush. His starscapes were not for sale. He showed them only to intimate friends and the one cousin he could call family.

PAINTINGS BY BOB VENOSA

There was no need to turn his paintings to rent, food, or utilities. He had no need for fame. He made clear choices. They involved time. His own time. Free time. Pure time. Soul time. Bought and paid for.

Certainly he yearned for more of those sweet hours. The older he got, the more he dreamed of a bonanza that would liberate him from the muck. He bought his lottery ticket like the rest of the tribe. But essentially, Herman accepted his situation.

In young September, when he first came to Shell Island, two fat months stretched before him like a plain. On his first days he walked leisurely along beaches, thought about meals, bent to examine shells. He set up the Heidelman on his deck and looked for his favorite stars. His early sketches and paintings were only rehearsals. Those drawings would end in the fireplace. The paintings would be painted over. He was in training. It was a necessary use of precious hours. There had to be some break between his life in the city and life out where the sky was a living organ instead of a sewer. By September seventh he was comfortably changed. And it was September eighth, at exactly 3:17 A.M., that the Feinbacher Galaxy came into view.

The Feinbacher Galaxy was Herman's special terrain. He didn't know why. Maybe it was because the Feinbacher appeared in months when the prices dropped on Shell Island and the weather was still reasonable. If Herman were a painter of women, the Feinbacher would have been his favorite model, with a flood of hair, avocado breasts, and a behind like joined honeydews.

For this painter of stars, the Feinbacher released passion.

Herman had first read about the Feinbacher Galaxy in a magazine for amateur astronomers called *Harvest Star*. It was not even given a full page. The Feinbacher was not part of any important star system. It was just another face in the glittering crowd. But when Herman searched it out and found it in the eastern sky, he knew immediately that it was his own. Feinbacher orbs twinkled at him, signaled to him. There was a hot connection over a million light-years. He did his best paintings. At September's end Herman always felt like he was rolling down a mountain. The luxury of two months became the rush of one. Soft plains of available time suddenly sprouted bent trees of anxiety, mushrooms of doubt. October days and nights flared, burned, and flew in the wind like the ashes from newspaper.

Herman was vulnerable when October came. He turned sad and defensive, feeling his own leaves turn. He envied insects and animals already drowsy with winter sleep. Fortunately, it was in October that the Feinbacher was most magnificent, most visible, most present. When Herman put his head to the Heidelman's eyepiece, he became witness to wonders. Always he saw something new. The Feinbacher was full of gifts. On chilly mornings he gulped orange juice and instant coffee and began to paint with eyes that still whirled images in urgent color.

Ten years of painting the Feinbacher had yielded more than a hundred oils and thousands of sketches. They ranged from dots of white on black squares to birthing shapes that could be faces or bodies or anything. Old, traveled light came through the Heidelman's tunnel and poured into Herman's brain. There it pooled with mystery. His hand held a brush that moved like the pointer on a Ouija board. He sensed some perfect fusion, deliciously elusive. He would capture it someday or die trying. Time, time, time. Two months a year was not enough to chase the kind of glory he suspected.

Once Herman saw a movie about settlers in the West who went through terrible indignities in search of a promised land. They stopped, collapsed only a hill away from a splendid valley filled with fruit, lakes, and lush soil to encourage the most reluctant seeds. One of their children saw the valley, but nobody would believe his story. The movie ended with a high camera showing the beaten pilgrims building houses of logs and mud on arid acres just inches from Eden. Herman cried and heaved while the film rolled the final credits. The usher brought him water. The pathos he felt was unbearable. It was not made up of self-pity or even of pity for all those who stopped too soon. It was the recognition of the worst of all possible jokes. He might be a whisper from the ultimate Feinbacher truth, whatever that was, forced to his knees and defeated by a cuckoo clock.

"Alone in his cottage he ate lettuce and sardines, slept as little as possible, forgot to smoke, hummed songs, watched the calendar melt, cursed the system, challenged the skies."

Meanwhile Herman persisted. Alone in his rented cottage he ate lettuce and sardines, slept as little as possible, forgot to smoke, hummed songs, watched the calendar melt, cursed the system, challenged the skies. He did the best he could.

In October's center, Shell Island weather turned foul. The place turned the color of a Brillo pad. Crusts of black cloud hung like barrage balloons. It stayed that way for three days and nights. Herman tried to work from memory, but that was no good. So he took to taking long walks down black-tar roads under dripping trees. He shuffled through spongy leaves and dead twigs. He roamed beaches with the look of damp cardboard. He collected bags of shells, then threw them away. Not a bird flew. There were no signs of clearing.

One sullen, rainy morning, Herman wandered to the rich part of Shell Island called Crescent Harbor. There great mansions hid in wooded hills overlooking the water. He went along thinking about the cost of such houses. Any one of them represented a lifetime of paid bills, including incidentals. He thought about the people who owned property like that. They owned time. They didn't buy lottery tickets. And they saved more money by not buying lottery tickets. It boggled the mind.

By October those temples were deserted. Small red signs, the eyes of rabid animals, warned trespassers away. PATROLLED. PROTECTED. WARNING.

The jewel of Crescent Harbor was Castle Avnolet, an authentic castle brought to Shell Island stone by stone, window by window, door by door from someplace on the Rhine. It even had a moat. The castle rested like a lump on the highest rise of land with a view of everything.

Herman went along a soggy beach stepping on horseshoe crabs that cracked under his sneakers. He looked up to the castle's towers. A curl of smoke twisted away from one chimney. Someone was in residence, but surely not the king or queen. They would be in Palm Springs or Palm Beach, listening to the stock market rise and fall in lulling waves. The resident would be a caretaker. On a whim, Herman walked up toward Castle Avnolet. Ominous billboards warned him against proceeding, but he went anyway. And what if somebody shot him for a prowler or mistook him for a deer? He would lay dying in the drizzle, thinking of the Feinbacher Galaxy until his own lights dimmed. Who would miss him?

He made himself an obvious target, walking briskly, as if circles and a bull's-eye were painted on his chest. But there was no evidence of the castle guard. No matched Dobermans salivated, waiting to pounce.

The castle was a magnificent conceit. Herman knew it had been bought and shipped by a family of manipulators who dated back a century before the Revolution. Eons of wheeling and dealing added up to a stupendous fortune. Their land on Shell Island was bought cheap after a horrendous storm that left the island desolate. When the puddles dried, the land soared in value. The castle itself had once housed a minor German conqueror, a modest despot who beheaded himself lamenting a lost war. The *Shell Island Reporter* carried articles about the castle's exotic history at least once a year. At the castle's iron gate, Herman looked through ornate bars to the sludgy moat. A lone duck swam there, probably a forgotten pet. More sensible ducks had left weeks ago. Beyond the moat was a drawbridge pulled up like a Murphy bed.

How nice it would be to have a moat with a duck and a door that gave the same protection as a turtle shell.

When the door began to lower with a grand creaking and moaning—a terminal

CONTINUED ON PAGE 88

ARTICLE

Both the cause and cure of disease, proteins are being remade to heal

BODY DOUBLES

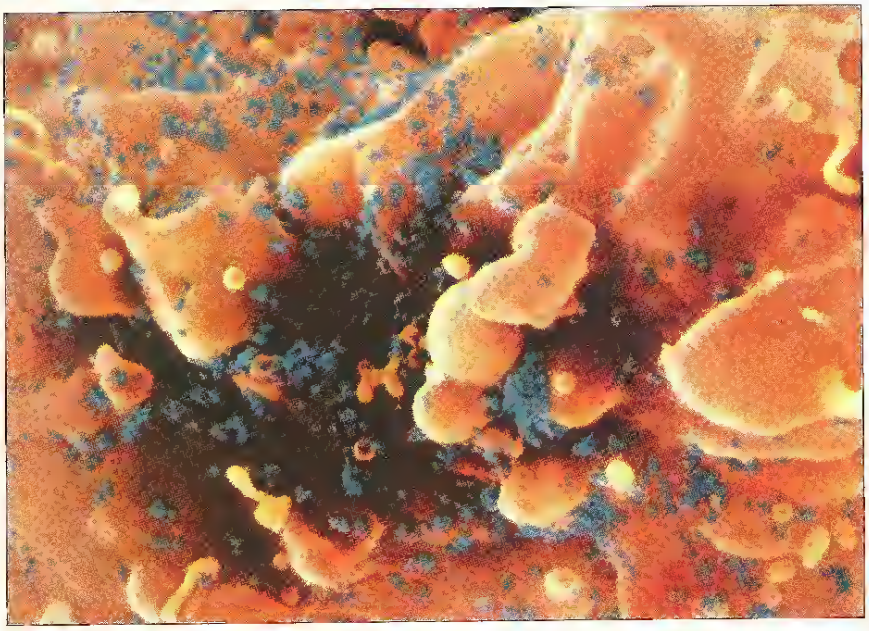
BY JEFFREY KLUGER

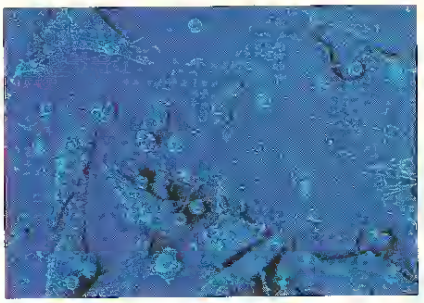
It was late afternoon in 1985, and Wolfgang Sadee was becoming impatient. For close to a week now the tall, graying scientist had been in and out of his University of California laboratory, squinting into a microscope at a handful of cells and waiting for them to grow. Not much of a trick for most cells, but these were nerve cells. They can't regenerate themselves. That's why people with damaged spinal cords usually have damaged spinal cords for the rest of their lives.

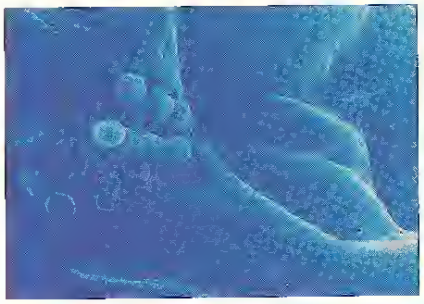
"During the gestation period our nerves grow with no trouble at all," Sadee explains in a heavy German accent. "But once we've developed, that process stops. Our bodies seem to lose whatever guidance system allows nerves to grow."

Sadee was watching this particular group of cells because of a hunch he had. A year earlier, a group of researchers had discovered a complicated protein that they called nerve growth factor (NGF). Sadee and other researchers suspected that NGF acted as the guidance system for the growth of gestating nerve cells and that it might also

"The potential of protein manipulation rivals that of the Salk vaccine and the Jarvik-7. It may change forever the landscape of disease."





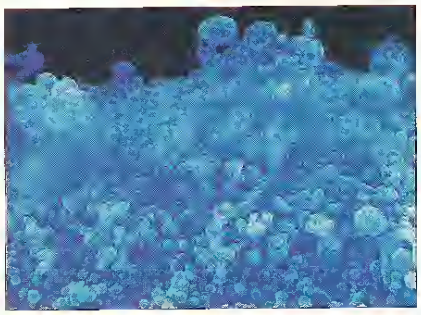


help to regulate fully developed ones.

After six days of patient—and painstaking—work, he got his answer. "I looked into the microscope and was astounded," he says. "The nerve cells were suddenly sprouting all sorts of interconnections among themselves. They were growing, weaving together. Somehow, just a few molecules of NGF had electrically excited them, making them do all sorts of things they ordinarily wouldn't do. This protein is remarkable stuff"—as it turns out, the stuff medical dreams are made of.

Sadee suspects the protein will be instrumental in helping to heal injured spinal cords and to treat Alzheimer's disease and certain childhood cancers. But NGF is only one of a battery of proteins whose secret powers are being revealed in a new branch of medical science that may change forever the landscape of disease.

This new science involves nothing more glamorous than proteins—or, more specifically, the manipulation of proteins. But its potential rivals that of the Salk vaccine and the Jarvik-7 put together. With simple tinkering, proteins may have the capacity to control cancer, heart disease, diabetes,



By manipulating proteins, there's a chance that the most vicious viruses can be controlled—perhaps even AIDS. That virus is pictured here as small, round or hexagonal dots (enhanced with a blue tint in the photo at top left) infecting T lymphocyte immune cells. All photographs © Boehringer Ingelheim International GmbH.

and AIDS, speed wound healing and bone setting, treat kidney disorders, ease the pain of childbirth, and lead to a safe, reliable contraceptive. Within a decade, maybe two, nearly half of all existing therapies or drug treatments could be thrown on the medical ash heap, replaced by the results of protein manipulation.

The premise behind the new science is simple. There are two basic molecules of life: nucleic acids and proteins. "Nucleic acids are our raw materials," says cell biologist Frances Brodsky, a colleague of Sadee's at the University of California at San Francisco (UCSF). "They have one important job: to build proteins. And proteins are nothing less than the functional molecules of our bodies."

Hormones are proteins, antibodies are proteins, neurotransmitters and other brain chemicals are proteins. Cells, tissues, and organs are all made of proteins. It's proteins' omnipresence that is central to their potential. Learn to alter one protein to change the course of one malady and you can apply the technique to a host of other problems. That's the theory, anyway, and it seems to be paying off.

Scientists learned long ago that some proteins are rather simple—necklaces of a couple dozen amino acids linked end to end in a specific order. Other proteins are impossibly long, tangled affairs, composed of hundreds, even thousands, of amino acids. Each is built by the body with exquisite precision. Not one more acid than is needed is in each chain, and not a single link is out of order.

Though nature has been assembling proteins since life began on Earth, it wasn't until the 1970's that scientists made their first tentative efforts to whip up some of the stuff on their own. The investigators discovered that at least for simple proteins like insulin, the manufacturing job could be relatively easy. Simply hang one amino acid from a thin rod made of organic resin, then chemically attach another and another and another, until a strand of the desired composition and length is achieved. "It's like an electric train set," says clinical pharmacologist Ferid Murad, acting chair of Stanford University's department of medicine. "You just keep adding the right amino acids until you've got the protein you want."

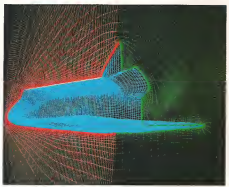
For more complicated proteins—anything longer than 30 amino acids or so—

CONTINUED ON PAGE 106

MACHINE DREAMS TAKE FLIGHT

SILICOSMS

Below and at far left: Flow lines of turbulence are drawn streaming over the body of a space shuttle. At near left, the computer-generated patterns of turbulence are shown on a model of the aerospace plane.



BY RON SCHULTZ

Exploding into flight with a flurry of brilliant color, the experimental airplane edges toward unheard-of speeds—7, 14, 25 times the speed of sound. The pilot, undisturbed by the enormous stresses, his craft must withstand, pushes the plane to its top speed of 18,000 miles per hour—and coolly monitors the violent turbulence that buffets him and his hypersonic aircraft.

The plane is a phantom, a supercomputer's vision of the yet-to-be-built national aerospace plane. The pilot, a gifted scientist, sits at a computer console at the ultimate flight-test facility, NASA's Numerical Aerodynamic Simulation (NAS) program. The program was recently launched at the agency's

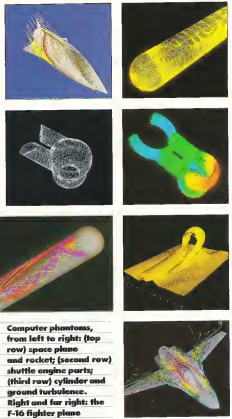
Ames Research Center in Mountain View, California.

Able to perform up to 2 billion calculations (2 gigaflops) a second, NAS is the most advanced computer system in the world. Its computational power will revolutionize how tomorrow's aerospace vehicles are designed and tested.

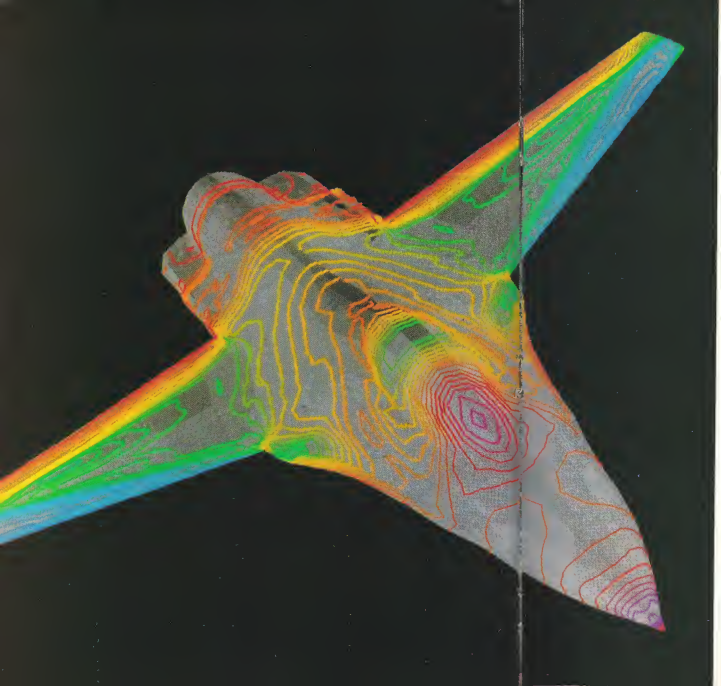
NAS allows scientists and engineers to take the abstract formulas of aerodynamics and bring them to life on the computer screen. Any aircraft or spacecraft that can be imagined, they can construct.

Furthermore, NAS permits researchers to "fly" their fantasy craft inside the computer at speeds that no airplane has achieved. This ability is especially critical in the prototype design of the national aerospace plane, which will be capable of reaching orbital speeds up to Mach 25. There isn't a wind tunnel in the world that can possibly test airflow effects at those velocities. (Most wind tunnels can simulate flight up to a speed of only Mach 7, and a few go up to Mach 14.)

At the heart of the system is the elegant Cray-2 computer. Curved in the shape of a C, this



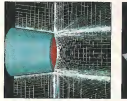
Computer phantoms, from left to right: (top row) space plane and rocket; (second row) shuttle engine parts; (third row) cylinder and ground turbulence. Right and far right: the F-16 fighter plane

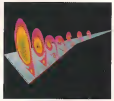


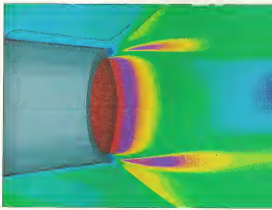
four-foot by four-foot processor is packed with high-powered chips and has its own equivalent of Mellabood coursing through its system. Having components compressed in so small a space creates a heat buildup, so the Cray-2's computer chips must be immersed in a fluorocarbon fluid that cools the dense circuitry. (The fluorocarbon is the same substance used in artificial plasma.)

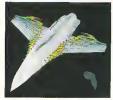
Besides being able to render its grids and waves the airflow patterns that enfold an aircraft traveling at high speeds, the NAS can model other complex realities. In the future, scientists will use the Cray-2 to study the dynamics of chemical reactions, to conjure up and study the elusive interactions of weather systems, and to see what happens when they make computer-generated galaxies collide with one another.

With its awesome computing abilities, the Numerical Aerodynamic Simulation is the scientists' ultimate fantasy machine. It gives design engineers the ability to witness the unseen beauty and elegance of a world that mathematicians have always known existed. ☐









Aerodynamic pressures on a plane wing (top right). The airflow at a jet exhaust (top left and directly above). The imprint of Mach speed stress upon the fuselage and wings of a jet (left and far left)

"I visualize a time when we will be to robots what dogs are to humans, and I'm rooting for the machines," says the founding father of the electronic communications age

INTERVIEW

CLAUDE SHANNON

Much to his discomfort, Claude Shannon, at seventy-one, is a living legend. What Louis Armstrong was to jazz, Shannon is to the electronic information age: a founding father who laid down its most important principles. His contributions are saluted by the world. Diplomas and prizes stretch along a wall and up a spiral staircase in his home. There would be a Nobel too, if one existed in mathematics. But Shannon has shunned fame. His face is so unfamiliar that when he arrived at a recent conference in Brighton, England, devoted to the field he founded, he was hardly recognized. In the dining hall a man cried excitedly, "Do you know who's coming? Claude Shannon!" as Shannon sat at the next table.

Not that Shannon is unsociable. Spared the cross fire of media inquiry, he cannot resist a joke, gadget, or prank. He is vividly remembered at Bell Labs for riding a unicycle up and down a long corridor, juggling all the while. One

PHOTOGRAPH BY BRIAN WOLFF

plaque on his wall is from the Whammo Company for his rocket-powered Frisbee.

Playful prankster or not, Shannon's discovery lit a beacon, and for decades engineers have steered into the future by its light. As a twenty-two-year-old MIT engineering student in 1938, Shannon first soared to prominence for his M.A. thesis, which Howard Gardner, the Harvard mind theorist, calls "possibly the most important master's thesis of the century." Shannon's brilliant, prizewinning paper demonstrated that the strict logic of Boolean algebra could symbolically represent the relay switching circuits used in telephone exchanges. (Boolean algebra is a branch of mathematics that represents relationships symbolically.) Essentially, "If the alarm clock rings and it is Monday, then you have to go to work" is the linguistic equivalent of "If switch A is closed and switch B is closed, then current flows to the motor." Shannon saw, then, that the relationship between electronic switches and currents could mimic the intellectual processes of symbolic logic and higher math. The insight was heroic. "You could now use mathematics to calculate if a design was correct, instead of using trial and error," notes Marvin Minsky, MIT's artificial intelligence guru.

Ten years later, while working at Bell Labs, Shannon published *The Mathematical Theory of Communication*. This masterwork provided electronic communications with a set of general theorems that formed the groundwork of "information theory." In a single stroke Shannon spelled out the principles of the signaling of information in concise, elegant math. It was a contribution of comparable significance to Newton's laying down the laws of motion for mechanics. Suddenly engineers had a language to deal with the major puzzles of telephone and radio communications: how to measure information and thereby fully exploit the capacity of telephone wires, microwaves, or fiberoptic cables as channels of communication.

What astonished engineers was Shannon's proof that however "noisy" a communications channel, you could always send a signal without distortion. If the message is encoded in such a way that it is self-checking, Shannon showed, signals will be received with the same accuracy as if there were no interference on the line. A language, for example, has a built-in error-correcting code. Noisy party conversation is intelligible partly because half the language is redundant. The extra symbols enable you to fill in what you miss.

Over the next 25 years Shannon's powerful codes yielded superaccurate communications hardware. Drag a knife point across the surface of a compact disc and error-correcting codes will mask the flaw, thanks to Shannon. *Voyager II*'s beaming back detailed pictures of Uranus and its ten newly discovered moons 1.8 billion miles to Earth is a tribute to Shannon's inspiration. So are the picture-perfect digital TVs and VCRs and compact discs on the home market. Information theory spurred the digital revolution, where information is sent in discrete bits rather than in the wave form of "analog" signals because Shannon's error-correcting codes work naturally in digital.

After writing his Ph.D. thesis at MIT on the mathematics of genes and heredity, Shannon joined Bell Labs in 1941 and during World War II worked on cryptography. A theorem of Shannon's was behind the SIGSALY telephone, the huge speech-scrambling apparatus that allowed Churchill to speak to Roosevelt from a special, toilet-size booth. Its coding system remains uncracked. Much to the regret of colleagues at Bell, Shannon returned to MIT in 1956. "It was a big loss," says Edgar Gilbert of Bell Labs. "He would grasp the essence of a problem immediately and come up with a totally different idea that shed a great deal of light on it."

Made Donner Professor in 1958, Shannon gave "beautiful" lectures, took a few select graduate students in tow, and refined information theory. By the mid-Sixties his preference for working at home became the rule. Borrowing Shannon's long-deserted office, a friend once found a sizable uncashed check more than a year old. Shannon retired in 1978, wealthy from investments in technological companies, some founded by his friends.

> *"Many things I've done I've never written up. Just lazy, I guess. I have a file upstairs of unfinished papers. But that's true of most of the good scientists I know."*

Not just a theorist, Shannon has always been fond of inventing and building gadgets and machines. His mechanical white mouse that, decades before the microchip, could learn its way through a maze has become legendary. A "mind-reading" machine anticipated whether a challenger would choose heads or tails. Colleague David Hagelbarger actually invented the prototype, but Shannon's stripped-down version, he says, outsmarted his own "more conservative and pompous design." Shannon's prankish side came out in the design of Hex. This machine, which played a board game, cunningly concealed the fact that it had an unfair advantage.

A visit to Shannon's large house down a shady lane a few miles from MIT suggests that his home life has not been dull. The house is filled with musical instruments—five pianos and 30 other instruments, from piccolos to trumpets. The chess-playing machines include one that moves the pieces with a three-fingered arm, beeps, and makes wry comments. A chair lift he built to take his three children 600 feet down to the lakeside has been taken down now that they are grown.

Shannon's lifelong fascination with balance and controlled instability has led him to design a unicycle with an off-center wheel to keep the rider steady while juggling, and a tandem unicycle that no couple has yet managed to ride. Today Shannon's keenest passion is juggling. In his toy room is a machine with soft beanbag hands that "juggle" steel balls. But his juggling-model masterpiece is a tiny stage on which three clowns juggle 11 rings, 7 balls, and 5 clubs, all driven by an invisible mechanism of clockwork and rods.

When writer Anthony Liversidge visited, Shannon was just back from Kyoto, Japan, where he had given a speech and collected an award in company with French composer Olivier Messiaen. He was quick to show off family photos, a computer printout of his stock portfolio, and all his toys. Betty Shannon, a math graduate who met her husband at Bell Labs, was his partner in the constant merriment.

Omni: How many balls can you juggle?

Shannon: Four. At five I don't last very long! I get them up there, but catching them is a different matter!

Omni: Did your genius come unannounced, or was there science and invention in your background?

Shannon: My grandfather was an inventor who had some patents—a washing machine, stuff like that. He was also very interested in determining the exact turn of the century. Was it 1900 or 1901? He owned a farm and was always inventing farm machinery. My father, Claude, was judge of probate in Gaylord, a little town of about three thousand in Michigan. If you walked a couple of blocks, you'd be in the countryside. Here is a picture of me playing the E flat alto horn in the town band. Here's my mother, who was principal of the high school in Gaylord. She was very intelligent. My father was clever mathematically and knew what he was talking about, although he didn't work in the field.

There was not much scientific influence from my father. He was a little distant, although he helped me when he could. I used to work with Erector sets. A friend of mine and I had a telegraph system between our houses, half a mile away, and we built the parts for this line for Morse code signaling. Later we scrounged equipment from the local exchange and connected up a telephone. I was always interested in building things that had funny motions, but my interest gradually shifted into electronics.

Omni: Funny motions?

Shannon: Yes, like those dancers in burlesque theater I saw as a young man! They

had an especially interesting motion. Cheap joke!

Omni: When were the Erector sets?

Shannon: In the seventh grade or so. After Betty and I got married, I said I'd always wished I'd had a number ten Erector set [the most complex set available]. She gave me one for Christmas!

Betty Shannon. I went out and got him the biggest Erector set you could buy in America. It was fifty bucks, and everyone thought I was insane!

Shannon: Giving it to a grown man! But it was really extremely useful—I used it to try out different ideas. Now I have a number ten Meccano [British version of an Erector set] and two others as well. I am always building totally useless gadgets just because they're fun to make. They have no commercial value but may be amusing.

Omni: Their "uselessness," then, doesn't really bother you?

Shannon: That would be the *last* thing! Here's a picture of me riding a unicycle and juggling at the same time! That was more than thirty years ago. You wouldn't believe the number of unicycles we have in our garage, along with similar wheeled vehicles of very odd types.

Omni. You once created quite a stir by juggling while riding a unicycle through the corridors of Bell Labs!

Shannon: Yes, I did! Those people are very far-out, but this was something that had never happened in the halls before. I worked at Bell Labs for fifteen years and then was a consultant. I found it very good. To begin with, you could work on your own ideas. They didn't come and say, "Work on this!" At least, not to me. The people in my mathematics research group were all very bright and capable, so I got a lot of interaction [feedback, discussion] about things I was working on. Had I been in another company aimed more at a particular goal, I wouldn't have had the freedom to work that way.

Omni: William Shockley, one of the inventors of the transistor, was at Bell Labs when you were there. Did you know him well?

Shannon: I walked into his office and he had this little object on his desk. I said, "What's that?" "It's a solid-state amplifier," he said, explaining that it amplified like a vacuum tube. This was the transistor in its first state. Right there I got a grasp of its importance because of its small size. I consider Shockley, his team, and John Bardeen to be the creators of the most important invention of the century.

I did most of my best work while I was young. Looking at the history of great scientists, such as Newton or Einstein, you find that their greatest creative work was done usually between twenty and fifty.

Omni: Did you always feel that you were destined for fame?

Shannon: I don't think so. I always thought I was quite sharp scientifically. But scientists don't generally get the press of politicians or authors. They have a limited audience of mainly other scientists. Even so, I thought my paper on switching was quite good, and I got a prize for it. I thought my information paper was very good, and then I got all kinds of acclaim for that. I tell you—a wallful of prizes and stuff in the other room. Ha-ha-ha! And sometimes I get asked to make speeches. I really don't like giving speeches, but sometimes, I suppose, I owe it to my public, so to speak!

Omni. Why not make the same speech over and over again?

Shannon. I sort of do, but I forget it and have to write it again. It's no fun to make the same speech twice. I spent quite a time trying to write a speech for the Japanese. What the hell did I say? I don't remember! Ha-ha-ha! I guess it went down well. Everything was translated into three or four languages. Most of the audience was Japanese, and I was speaking in English. Being very polite people, they would have clapped if I had read the Lord's Prayer.

During my little speech in Brighton last year, I was getting no reaction at all from the audience, so I pulled out these three balls and started juggling. Suddenly everyone looked up. There was great excitement, though that's the most trivial thing in the world!

"This motorized pogo stick is gasoline driven and has a piston that fires each time it comes down. You go along at great velocity, but I found it very uncomfortable."

Omni Have you ever analyzed juggling mathematically?

Shannon. I wrote a paper for *Scientific American*, which I'm still revising. My theorem relates how many balls you are juggling to how long each one is in the air. In uniform juggling, the ball stays in the air the same amount of time, and when it hits your hand it stays there for the same amount of time. I visualize a person with not just two, but several, hands juggling. You could even have several different people juggling simultaneously. My theorem relates five quantities: the number of hands, the number of balls, the time your hand is empty, the contact time, and the flight time of the balls. These five things all connect in a very simple relationship, which would be exciting to nobody except a few mathematically inclined jugglers. Ha-ha! Juggling relates to patterns. There's a topology and a combinatorial aspect to it that mathematicians find interesting.

Omni. Would your theory lead to a way of juggling more objects than ever before?

Shannon. The more balls you juggle, the higher you have to throw them in order to get more time. This theory indicates how much higher you have to throw the balls, depending on the number you are juggling. I've measured jugglers with a stopwatch and observed how they juggle seven balls, a very hard thing. They have to throw them very high. I even put metallic strips on jugglers' hands and had them juggle metal-covered balls so they'd close a contact when holding the balls. Then I ran these data into electronic clocks that measured the time, and checked this all out.

Omni. Why haven't you commercialized your three juggling clowns?

Betty Shannon. Oh, fiddle!

Shannon: Well, there wouldn't be too much of a market.

Betty Shannon. We don't believe in commercializing fun.

Omni: You have quite an array of computerized chess machines in your toy room. Do you still play chess?

Shannon. I don't play at all.

Betty Shannon. He used to play very well. Good enough to play Mikhail Botvinnik in Moscow. Claude, by God, got the exchange [got ahead]. Botvinnik was worried. Botvinnik finally pulled it off, but it was really very close.

Omni. Where did you find all your chess machines?

Shannon: At this store in Los Angeles.

Betty Shannon. Claude went hog-wild!

Shannon. Yes, I actually bought one of each. Ha-ha!

Omni: Do you find it depressing that chess computers are getting so strong?

Shannon. I am *not* depressed by it. I am rooting for the machines! I have always been on the machines' side. Ha-ha!

Betty Shannon: Some people get livid when he says that.

Shannon. I am not depressed by machines getting better. Whether people will be replaced by machines that have gotten smarter in all things, I can't say. Within a century or so, machines will be doing almost everything better than we can. They already do factory work better than we can, but the highly intellectual stuff is going to come later. It gets harder and harder as you get higher and higher in this game.

Omni: Do you agree with Norbert Wiener's denial of any basic distinction between life and nonlife, man and machine?

Shannon: That's a heavily loaded question there! I am an atheist to begin with. I believe in evolutionary theory and that we are basically machines but of a very complex type, far more so than any machine that man has made yet. So that's both a yes and a no. *Mechanical* doesn't just mean that metal and gears are involved, of course. We are the extreme case of a natural mechanical device. I see no God involved.

Omni: Will robots be complex enough to be friends of people?

Shannon: I think so. I myself could very

easily imagine that happening. I see no limit to the capabilities of machines. As microchips get smaller and faster, I can see them getting better than we are. I can visualize a time in the future when we will be to robots as dogs are to humans.

Omni: Can you imagine a robot president of the United States?

Shannon: Could be, but I think by then you wouldn't speak of *the United States* anymore. The world will have a totally different organization.

Omni: Is it a big leap from the pedestrian routines of today's chess computers to machines that could grapple, seemingly in a creative, intuitive fashion, with the problems of higher mathematics?

Shannon: I see computers proving theorems that have been sitting around that nobody's proved. I don't yet see them *creating* theories, that is, discovering a new branch of mathematics, as many great mathematicians have in the past. That's a broader, wider thing—more like writing a play—and will be a lot longer in coming.

Omni: Is your famous proof that a reliable circuit can be built from unreliable components relevant to the brain's operations?

Shannon: The brain can suffer all kinds of damage and yet can still handle things pretty well. It must use some redundancy to take care of faulty operations, such as the death of certain neurons. The modern desk computer generally has no redundancy, so if one part gets into trouble, that will show up in later operations. That we manage to live in spite of all kinds of internal troubles suggests the brain's design involves a great deal of redundancy or parallelism of multiple units.

Omni: Your paper shows that if the relays closed only sixty percent of the time when triggered, you could still have highly effective circuitry. Could the brain be using such an approach?

Shannon: That the brain has ten billion neurons probably means it was cheaper for biology to make more components than to work out sophisticated circuits. Yet I am totally astounded at how clever and sophisticated some of the things we see in human or animal bodies are. Such long-term, sophisticated changes could be what happened in the brain, but an easier way would be to use paralleling and multiplication to reduce errors of individual neuron operation. And when it all gets going, we have these clever people like Einstein.

Omni: Some recent experiments with rats suggest that the brain responds to stimulation even in old age, and there isn't an obvious reason why the brain shouldn't operate as well later.

Shannon: Did they ask those rats a hard mathematical question? Bit of an extreme extrapolation to humans, especially to people who are creative when they are young and all that.

Omni: How did you get to MIT?

Shannon: After I got my bachelor's from Michigan, I wasn't sure what to do. This little postcard on the wall said MIT wanted a research assistant to run the differential analyzer, a machine Vannevar Bush had invented to solve differential equations. I applied for the job and spent the next four years at MIT.

Omni: What in fact makes up the differential analyzer?

Shannon: The main machine was mechanical, with spinning discs and integrators, and there was a complicated control circuit with relays. I had to understand both and work on them. The relay part got me interested. I knew about symbolic logic and realized that Boolean algebra was just the thing to take care of relay and switching circuits. I got all the books I could on symbolic logic and Boolean algebra, started interplaying the two, and wrote this master's thesis. That was the beginning of my great career! Ha-ha-ha!

Omni: You saw the connection between a relay circuit and Boolean algebra. That was quite an inspiration!

Shannon: Oh, it's trivial—once you make it! The connection is not the great thing. The more important, hard part is working out the details, like how to interleave the topology of the switching circuits and how contacts within the circuits are connected with the Boolean algebraic expressions. That was a lot of fun, working that out. I had more fun doing that than anything else in my life. It worked out so well that when I finished, it was shown to people there. Vannevar Bush, then vice president and dean of engineering at MIT, was very impressed and wrote a recommendation to get it published.

Omni: Was your basic insight that yes/no can be embodied in on/off switches?

Shannon: It's not so much that a thing is "open" or "closed"—the "yes" or "no" you mention. The real point is that two things in a series are like the word *and*, whereas two things in parallel are like the word *or*—"this *and* this" versus "this *or* this." Some contacts close when you operate the relay, others open. All those things together form a complex connection between Boolean algebra, if you like, or symbolic logic, and relay circuits.

People working with relay circuits knew how to make these things, but lacking a mathematical apparatus like Boolean algebra, they weren't very efficient. Much of my work used this math to minimize circuitry, to get the smallest number of contacts.

Omni: A supposedly major mathematician criticized your treatise *The Mathematical Theory of Communications* as lacking mathematical honesty because your results weren't proved, he said, with mathematical rigor—i.e., with the complete generality mathematicians like. How did you react to his hostile review?

Shannon: I didn't like his review. He didn't read my work carefully. You can write mathematics line by line, with each tiny inference indicated, or you can assume the reader understands what you are talking

about. That's what I did. I was confident I was correct—both intuitively and rigorously. I knew exactly what I was doing, but maybe it takes people a little brighter to understand it. You can always find new proofs of things, better proofs, shorter proofs, and some of those things went on later at MIT.

Omni: What impact did your information theory have on the field of communications engineering?

Shannon: On the philosophical level, one is able to understand the communication process by measuring information in so many bits or choices per second. On the actual operational level, it enables you to combat noise and send information efficiently by working out the right amount of redundancy to decode at the receiving end, despite noisy communication.

Omni: In the Fifties you criticized people for applying your ideas to fields other than line communications. Recently, in the book *Grammatical Man*, Jeremy Campbell has again suggested that they may be widely applicable. Are you as skeptical now as you were then about such attempts?

Shannon: I am, and always was, interested in information theory in the narrow sense of communication work. It's possible to broadly apply the term *information theory* to all kinds of things, whether genetics or how the brain works or this and that. My original ideas were related to coding information for transmission, a much narrower thing. But some of these applications may be valid. For example, animals and humans transmit information along nerve networks. And the nervous system isn't very precise and accurate. It is a noisy, redundant system.

Something similar happens in the social system, where we have lots of aids to communication. If you're talking to me, I might say, "What?" This is a feedback system to overcome some of the noise and get correct transmission. I see it like that frequently, all over the place, mostly crude systems—not scientific or mathematical.

Omni: Does information theory hint at how complex life forms might have evolved, seemingly in the face of the second law of thermodynamics, which says order is slowly disintegrating?

Shannon: The evolution of the universe is certainly a very puzzling thing, to me as well as to everybody else. It's fantastic we've come to the level of organization we have, starting from a Big Bang. The second law of thermodynamics is not so simple as to say that from that Big Bang you couldn't get anything more than disorganization. There's a lot of energy there, so you can get local organization at the cost of overall increase of entropy. I've puzzled many hours about the gradual organization of life, the structure of knowledge, and all the things we humans have. It's the most incredible thing! I'm not a religious man, and it would not help if I were!

Omni: Would you say information theory is a substitute for belief in a God?

Shannon: I certainly would not! While I may be a proponent of information theory and a great believer in it, other theories can be developed to show how an overall increase in entropy as time goes on can produce order in certain subsets of the universe. The steam engine, for example, uses disorganized heat energy to produce organized mechanical energy but only at a certain cost. Entropy is the overall "price" the universe pays to produce all these wonderful things.

Omni: Has your ambition waned at all?

Shannon: I was never motivated by the notion of winning prizes or the desire for financial gain. My motivation in science has always been curiosity about something. How is it put together? What laws or rules govern this situation? Are there any theorems one can prove about what one can or can't do? After I had found answers, it was always painful to publish, which is where you get the acclaim. Many things I have done and never written up at all. Too lazy, I guess. I have got a file upstairs of unfinished papers! Ha-ha-ha! But that's true of most of the good scientists I know. Just knowing for ourselves is probably our main motivation.

"The simplest mirrored room is a cube where you'd see an infinite series of yourself receding into the distance. But tetrahedra would yield more interesting patterns."

Omni: Your success in the stock market obviously hasn't diminished your desire to work hard.

Shannon: Certainly not—and we were very successful, too. I even did some work on the theory of stocks—again not published, although everybody wants to know what's in them! Ha-ha! Some twenty years ago I gave a talk at MIT outlining some math on this subject. To this day people ask about it. Just last year when we were over in Brighton, more than one person came up and said, "I heard your talk at MIT about the stock market!"

Omni: Your stock market success was based on mathematics?

Shannon: Mathematics and some good friends! More important thing, that. One of my good friends since college days was Henry Singleton, head of Teledyne. When he started his company he asked if I'd like to invest. We put as much as we could into Teledyne, and it has gone off like crazy. That was in 1961. We had already had one good experience with Bill Harrison, because Harrison Laboratories merged with Hewlett Packard in 1953. We've had quite a few things like that. We do study graphs and charts, but the mathematics is not as important, in my opinion, as the people and the product.

Omni: What was the lecture at MIT about?

Shannon: The best way to balance a portfolio, the optimal amount you should have in different stocks to maximize the logarithm of the current value of the portfolio. But if you make money, it becomes very painful to sell that stock because you have to pay a capital gains tax. This tends to negate all the theoretical thinking! People always look at the stock price when they should study the basic company and its earnings growth. There are many problems with stochastic prediction [involving random probabilities] of stochastic processes, especially in relation to the earnings of companies. When we consider a new investment, we look carefully at the earnings of the company and think a lot about the future prospects of the product. We're fundamentalists, not technicians.

Omni: Haven't you been lucky?

Shannon: Far beyond any reasonable expectations. Economists talk about the efficient market, where everything is equalized out so that nobody can really make any money. But I don't believe that's true. These are our current stocks. [Shannon produces computer listings.] The annual growth rates are punched out every night by our machine, a prehistoric Apple II that Steve Jobs [one of Apple's founders] wired together himself.

The annual compounded growth rates of our stocks here since we bought them, most quite a few years ago, are thirty-one percent a year, eleven percent, one hundred eighty-five percent, thirty percent, thirty-one percent, one hundred eighty-one percent, ten percent, eighteen percent, one hundred fourteen percent, twenty-one percent, two percent, and twenty-seven percent. Ha-ha! That's our holdings—the whole list.

Omni: Which companies do you see as the big gainers there?

Betty Shannon: Ecology, a spinoff from Teledyne, has gone up like crazy. But we've only had it for a year and a half. The other is Kyocera. I bought it because the man who runs the company donated the Japanese prize that Claude recently was given. When I looked at the thing, it sounded interesting. And he sounded like a real hotshot laddie, so I went out and bought a little bit, and it's been going *zoomp*! That's luck! Kyocera makes ceramics—all kinds of electronics.

Shannon: We've held Teledyne for twenty-five years, and it's compounded twenty-seven percent a year. The difference between going up twenty-seven percent and ten percent, like you might get in a bank, is incredible over a twenty-five year span. [$100 compounded for 25 years at 10 per-

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FICTION

PATTERNS

BY PAT CADIGAN

You are about to enter a dimension of sight and sound—where you control reality

PHOTOGRAPH BY HUBERT KRETSCHMAR

I have this continuing fantasy of assassinating the President. Any president.

To step forward within a crowd, raising my weapon and aiming it at the President's head. Sometimes in the movie unreeling in my mind, my hand comes up holding a Luger Parabellum P08, with its ridiculously long one hundred-ninety-millimeter barrel.

Other times I am holding a more likely Mauser military pistol. Twice I have found myself clutching an Uzi with the stock detached; three or four times I held a .357 Smith & Wesson magnum. Once—only once—I stared down the length of a crossbow at the chief executive.

In the fantasy I am not scared or angry. I don't think about the fact that I am taking a human life—the President, after all, is not so much human as manufactured, a product made flesh by the bipartisan system and the media in accidental conjugation. Is it wrong to fire at the dot pattern on a TV screen? I feel nothing beyond a mild nervousness, the slight (very slight) stage fright I used to experience during my acting days. That my stage fright was never acute enough to give me the cold sweats or send me vomiting into the handiest receptacle probably contributed to my lack of success in the theater. In a one-person show, I could have been overlooked.

I know what you're thinking. I dream of assassination as a way to become visible at last. You are wrong. There is far more power in invisibility than in fame.

In fact, my fantasy movie has never proceeded beyond the point at which I raise my weapon and train it on the President. The action freezes when the President's gaze rests on the instrument of his/her destruction. But I know the rest of it.

I brace myself and fire. The President falls backward, face a red ruin, body jerking in every direction. He/she is caught by aides and Secret Service agents and lowered to the ground. The crowd is completely silent. They are neither frightened nor in shock, just passive as the dot pattern rearranges itself. I lower the weapon to my side, then turn and walk away without hurry. Nobody looks at me. I walk some unmeasured distance to a car I recognize as mine, parked at an innocuous curb. I get in, twist the key waiting in the ignition and drive off.

In the days to come, there will be no mention of what happened to the President, ever, nor will there be any news about the government again. With one shot, I have obliterated not just the President but both houses of Congress, the Supreme Court, Social Security, the National Endowment for the Arts, the Government Printing Office, the Gross National Product, the FTC, the CIA, HHS, and the Bureau of Immigration and Naturalization, among others, as well as postponed forever the next election year.

But life goes on anyway. I drive an endless highway across the United States, and through the windshield I observe the permanent status quo I have visited on the American people. They don't know what has happened, and they don't find it odd that they keep living in the same homes, working at the same jobs, hearing the same music on the radio, and watching the same dot patterns.

Like me, they travel without destination. The days melt into each other with no distinguishing characteristics. The seasons come in and go out as they were meant to do in textbooks, but no one grows older. The treadmill has achieved a state of being both in motion and at rest simultaneously. Test pattern. Entropy. All because I shot the President's dot pattern.

Seen in extreme close-up, the dot pattern could almost be taken for a collection of organisms, very cooperative organisms that have discovered a choreography that will produce patterns pleasing to the eyes of much larger and much less cooperative organisms.

Quotation from Chairman Busby Berkeley and Miss Amy Lowell. *'Christ! What are patterns for?'* I'll tell you.

"I brace myself and fire. The President falls backward, face a ruin, body jerking in every direction. The crowd is silent. I lower my weapon, then turn and walk away."

The screen crackles when I put my finger on it. Static electricity, the dots warning me off their pattern. I pull my finger back and make it a pistol barrel pointing at the President, who is giving the State of the Union address. The President looks directly at "me" and hesitates. The dots at work on his pattern burble and boil and show me the red ruin that could be the result of my gun hand.

Then the President's head re-forms, and he goes on with his speech. We are in great need of reform in this country, he says, but even so, the state of the Union in general is most hope inspiring.

Now. While there's still hope.

I cover the President's face with my finger. Loud crackling, followed by a close-up, which puts my finger absurdly on the President's moving mouth. He doesn't bite, but there is some mild electricity running up my arm.

"It was all them cop shows," his mother said. "All that violence, they oughta get it off the tube." She said it on television, at his televised trial. Christ! What are patterns for? First-degree murder.

"Always such a good kid," my mother would say. "Never a moment's trouble. Helped around the house and never answered back, either. Good-natured, you know. And when all the other kids were hanging out on the streets or chasing each other around and getting into trouble, *my* kid was studying. *My* kid always wanted to be somebody."

How true. I could have had my own show, in fact. If the technology had been good enough in those days, I might have lived in a suburban dot pattern, walked to school to my own theme music, mouthed dialogue to my own laughtrack. And achieved endless childhood in syndication. I could have been syndicated, I could have been a contender. Instead of a COMMERCIAL INTERRUPT FOR STATION IDENTIFICATION. It is often necessary to amputate a frame or two for the sake of format.

So sorry, apparently the program director spliced this one a little early. But since it happened anyway, you have sixty seconds to contemplate your mantra. *Now* how much would you pay?

Late at night, the patterns change and rearrange. I can't sleep. Two, three, four in the morning, the dots perform before my dry eyes. Slices, dices, juliennes. How much would you pay? Don't answer yet. Stainless steel, never needs sharpening. Now how much would you pay? Don't answer yet. . . act now and we'll throw in the fabulous Kalashnikov rifle, the most successful automatic rifle ever made! Gas operated, simultaneous bolt action and cocking, with a handy selector lever for single shot or automatic at a rate of one hundred rpm—that's one hundred rpm! *Isn't that amazing?* A mere eight pounds with a folding metal stock, perfect for the murder of the head of state of your choice! Call now, operators are standing by!

I blink. When you awake, you will remember everything.

I want to call friends to ask if they have just seen this, too. Then I remember, all my friends are electric.

In living color.

A Famous Actor has shot himself. When they found him, the television in his town house was still on, murmuring merrily to itself as it played one of his old movies. I see it on the six o'clock news. Dot pattern of a dot pattern.

Now how much would you pay?

I have taken to dreaming in dots. Reruns. I raise my arm. I am holding a Browning GP35. I know nothing about guns. Its rate of fire is twenty-five rpm with a muzzle velocity of one thousand, one hundred and ten feet per second, and it is going to make cheap chuck of the President's face. I know nothing about guns. The dot pattern knows.

Point blank range is that distance at which the bullet achieves its highest velocity, the distance the President is from me now. And it's on every channel, even cable.

Cable?

When I awake, I remember everything in dot patterns in living color.

A soap opera actress reports being assaulted in a restaurant by an irate woman wielding a Totes umbrella, shouting, "You leave that nice lady's husband alone you slut! Hasn't that poor woman had enough trouble without you trying to steal her man?" The actress's companions manage to pull the woman away. The rest of the people in the restaurant—diners, waiters, waitresses, busboys, maître d'—all watch. They are neither frightened nor in shock.

And now what will I do?

I consult the schedule. It is not time to run all the drug dealers out of Florida. Last night the score was evened for the right thinking on the mean streets of New York, it won't have to be done again for another week. I think I will defend my heavyweight title against the challenger in Las Vegas. I double up my fists and inspect the knuckles. Yes, these can go fifteen rounds, piece of Duncan Hines cake.

I press my knuckles against the screen. Wild crackling. The dots swarm in liquid patterns around each point of contact. Electricity is flowing up both arms, dancing through the nerve endings, which sizzle into life and join the pattern.

My hands are being taped as I hold them out. I got to keep my fuckin' hands up, do I hear, just keep my fuckin' hands up and let him dance himself out and then jab his motherfuckin' head off. The dots pulse. Live from Caesar's Palace, more live than life. Fitted out with this dot pattern to wear, I could strike sparks in the moving, living air.

Now I know it can be done. The fight goes by in a swirl of dot-pattern light. I keep my fuckin' hands up and let him dance himself out and then jab his motherfuckin' head off. The fight is not important. Now I know it can be done.

But I have to wait until the swelling goes down and the black eye fades. Never mind. You should see the other dot pattern.

More on that story from our correspondent in Washington.

Dot-pattern Washington snaps under the scanning line. The White House looks a little fuzzy. So does our correspondent. I touch her microphone, the dots leap in frenzy as I reshape their pattern into a hundred-twenty-seven-millimeter-barrel version of the Gyrojet pistol and then back into a microphone. Not yet. Tonight there is a press conference.

Brought to you by sponsored in part. The whole world is waiting and watching. Ladies and gentlemen on every channel, the President of the United States. The reception has never been so good. It must be me. The dots dance for me now, and we know each other: tropism. Whenever they appear, I turn to look, and my looking excites the patterns.

What are patterns for?

I'll show you. I'll . . . *show* . . . you. As I show myself.

The dots sparkle around my hands in the continuing fantasy shown live on every channel. I run my fingers through them like a helping of stardust and reshape the pattern. They know what I need here. The Colt Commando with telescopic butt fully extended for shoulder firing, as used by the Green Berets, who have also been on this channel. The dots remember the pattern, and here it is.

I step forward in the crowd of reporters demanding to be called on. The President's dot pattern scans the room, looking for a likely questioner. Then he sees "me" and hesitates. I have raised the Colt to my shoulder. Everyone is watching.

I touch my finger to the screen. The President's head disappears in a red mist, dot patterns gone insane.

The room is completely silent, neither frightened nor shocked. Behind the podium the Great Seal, the curtains, the President's aides, and Secret Service agents begin to unravel from the hole where the President's head was.

Embarrassed, puzzled anchorman: We are sorry for the interruption in transmission. Apparently we are having technical difficulties. We'll have more information for you after this.

No, we won't. That is all the information we are ever going to have, ever.

Fade to commercial. Dogs pounce on bowls of food. I sit on the couch, nodding. It's all over now. It wasn't quite how I expected it to go, but it was, after all, adapted for television.

The commercial is followed by another commercial and then the embarrassed, puzzled anchorman. Apparently we are permanently cut off from our hookup in the nation's capital. We will try to have some news on the rest of the press conference as soon as possible.

A fast recap of the statements and questions up until the moment I murdered the President's dot pattern, when things unraveled like celluloid melting away, a promise of an update soon. They patch the foreshortened evening schedule with a made-for-TV movie. Time to go.

I leave my apartment, go down to my car parked at an innocuous curb. The key is not waiting in the ignition but in my pocket. Such a good kid, never a moment's trouble. We can live in the same homes, work at the same jobs, hear the same music on the radio, watch the same dot patterns. We travel without destination. What are patterns for?

Nothing, anymore.

There used to be too much violence on TV. But not now. ∞

SPACE

CONTINUED FROM PAGE 20

the scientific community in an American biosatellite," Halstead adds, "but it'll go into limbo if we don't get the money."

Optimistic life scientists have been compiling a long list of *Lifesat* projects they'd like to try. "There are many things going on at the cellular level that we just don't understand," says cell biologist Millie Fulford, now training to be a payload specialist on Life Sciences Spacelab-2, a lab module to be ferried into space by the shuttle. She and others are interested in how space affects the way proteins and trace minerals move through a cell's outer membrane.

For example, in earlier experiments with rats in space, researchers noted a definite loss in the weight—but not the number—of the animals' muscle cells. The cells apparently were not making any protein. Some changes had occurred in cell metabolism—the transportation of nutrients in and out of the cell.

"There are channels and pumps in the cell that take up and get rid of calcium and other trace minerals," explains plant biologist Stanley Roux of the University of Texas. "We know cells can sense pressure, so it's possible that cell mechanisms are disturbed by zero gravity. It's also possible that fluid shifts subtly alter the cell's channels and pumps."

To find out what is going on inside an orbiting cell, Fulford needs basic information about microevents in its life. To start, she would take pictures of a cell dividing. In addition, she has plans for an experiment to analyze how a cell makes proteins. Using a substance called two-dimensional gel, she says, she can study how an individual cell synthesizes the hundreds of different proteins while in space. This, in turn, may offer clues about what happens to muscle cells in orbit.

Plans exist for research on larger systems as well. "We have to study how the heart, the nervous system, the skeleton, and all the connective tissues are laid down in embryos in space," adds Dick Keefe, a NASA anatomist who has already worked closely with the Russians on rat embryo experiments. "We all feel that postnatal growth and development will be disastrous for all mammals in zero gravity."

"Females are very sensitive to radiation," he points out, "so we have to study many generations of rats before we can ever speak of having human babies in space. If we cycle women through the space station repeatedly and expose them to various levels of radiation," he warns, "we will have to consider health effects on them and the children they will have."

We've learned how little we know about becoming inhabitants of space. And before we can understand how to prepare our bodies for extended journeys beyond Earth, we first have to know what happens to the cells within our bodies. ∞

STARS

CONTINUED FROM PAGE 24

in elliptical galaxies. "I figured they had something to do with mergers, but I didn't know what," Schweizer says.

When Alar Toomre saw the photos, he ran a few computer simulations to imitate what they showed. On his computer screen he got an effect strikingly similar to Schweizer's photos when a disc galaxy wrapped around and eventually merged with an elliptical galaxy. "I think it's still the best explanation," Schweizer says.

For a while Schweizer and Toomre were the sole believers in the cosmic-merger theory ("I felt like a lone wolf," Schweizer now admits). Supporting evidence came in 1983, after the Infrared Astronomy Satellite (IRAS) had scanned most of the sky over a ten-month period. IRAS found intense infrared radiation from the cores of some galaxies. The most logical explanation astronomers could offer for this hot glow was that it was the result of galactic collisions. When two galaxies slam together, the gas gets enormously compressed. "In the densest part of the gas, millions of stars form," explains Schweizer. The stars are not visible because they are surrounded by clouds of dust, just like L.A. on a smoggy day. But they are detectable. The stars heat up the dust, which radiates energy in the infrared. More "starburst galaxies" may yet be found, as astronomers are still analyzing IRAS data.

In 1985 theoreticians predicted that if these galaxies were forming stars as fast as people had claimed, there should be large-scale galactic winds produced by the starbursts. The following year two University of Maryland astronomers found just that in the galaxy NGC 6240.

In 1983 astronomer Allan Stockton had made more discoveries supporting the merger theory. First he found two quasars with two large tails. This indicated they had been formed by the merging of two disc galaxies. He also found three quasars surrounded by strange companion galaxies. These satellite galaxies, Schweizer explains, provide fuel for the quasar, which he calls "the monster lurking in the center."

As a result of the Toomres' theory and Schweizer's work, astronomers now believe that galactic mergers may not only explain the strangely formed galaxies that exist, but they could be the force behind the formation of quasars. A galactic collision, says Schweizer, "is the best crunching mechanism in nature." Quasars are objects the size of stars but are up to 1,000 times brighter than the brightest galaxies. Because they burn so intensely, they are short-lived, with only 1 percent of the life span of an average galaxy.

Our galaxy has no quasar at its center now, but that may not always be the case. Schweizer warns that the Andromeda galaxy and the Milky Way appear to be on a collision course and could meet—in about 10 billion years or so. "If they ever hit, we might merge, form an elliptical galaxy, and for a brief moment form a quasar."

In the meantime the merger theory will shape the future of astronomy, specifically how researchers will use the Space Telescope Infrared Facility (STIF), due to be launched in the mid-Nineties. Thanks to the Toomres' theory, STIF users will be paying special attention to the glowing infrared cores of galaxies. Like IRAS, STIF is capable of detecting infrared light emitted by stars through clouds of interstellar dust and can do it with 1,000 times as much infrared sensitivity. Researchers hope to find even more evidence for interstellar collisions and get more detailed information about galactic and stellar evolution.

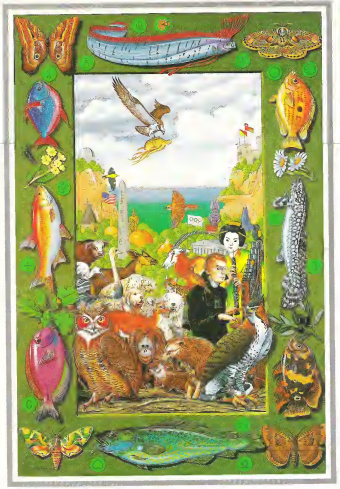
The man responsible for this dramatic change in astronomical thinking remains modest. Alar Toomre today dismisses his seminal calculations as "just elementary stuff that could be worked out in a week." Yet he still gets pleasure from the fact that what he originally saw on his computer screen, astronomers found in the heavens. "You can see this phenomenon over and over again, in spiral galaxies, whirlpools, ellipticals, and quasars," he marvels, "all from those stupid calculations."

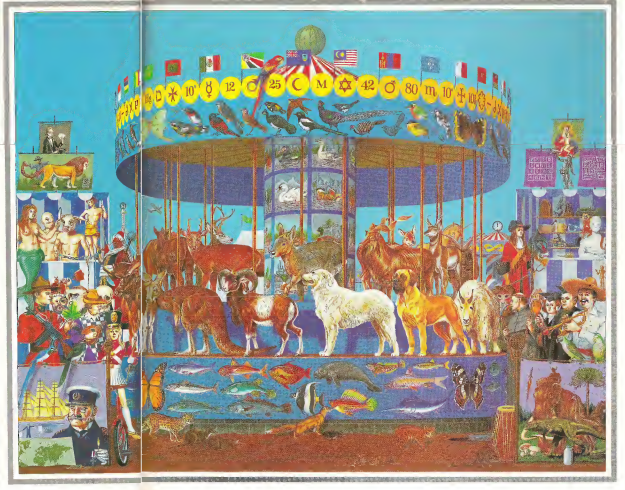
THE OMNI ALPHABESTIARY

PAINTINGS AND TEXT BY MIKE WILKS

A picture of pictures. Portrayed here you can find a painter in profile clad in P's whose palette is charged with appropriate colors, a patchwork quilt of pertinent hues, a pineapple, a pestle, a press, and some proofs (can you place the image?), a partially painted panda, a plethora of pargeting on appropriate material, a paperback publication, and plenty of patterns for you to put into perspective. Perspicacious persons may perceive more than the 810 P's I painted on purpose.

The paintings reproduced are the result of an idea that occurred to me several years ago. My original concept was to create a set of pictures—one for each letter of the alphabet—and to attempt to include in them images of *everything* known. But my research indicated that it would, with luck, take me 20 years to complete the task. I completed a scaled-down version of that original idea in four years. On the pages that follow, the pictures selected spell out a familiar name





Observe the buildings overlooking the ocean, and also look for an owl, an ostrich, an ox, an okapi, an orangutan, and an ounce that weighs many a pound. There are two musicians—an oboist from the East and an organist from the West. The observant will locate my 157 O's in the picture above at left.

For four years I was on a journey. The place I visited is not to be found in any atlas, but it has proved to be unendingly fascinating and full of wonders, many of which were new to me and many of which I delighted in rediscovering. My journey had 26 stops on the way where I paused to make a painting and tried to capture on canvas some of the spectacles that I found there. The name of this place is the English language, and on these pages are just a few of the pictures that I brought back with me from the grand tour.

Literally painted 409 words into this picture. There is a multitude of mammals on the midway, including a monk, a minstrel appropriately dressed but recently bereaved, a Mountie, and a monarch with attractive regalia. There are myriad mythical creatures as well—a manticore, a reflective mermaid, and a muscular Minotaur in shackles. There is a musketeer with the tools of his trade, a marionette, a mullion, and somewhere a (deliberate) mistake.

I spend between 12 and 14 hours a day, seven days a week, at my work, and a painting such as this would occupy me totally for four months.

The artist inhabits an insubstantial land of shadows and essence where reality and illusion freely intermix to create the eccentric, sometimes the haunting, rarely the marvelous.

Find the numbers 9, 19, and 90 twice over, and name the constituents of the nosegay. There are also a nun, a nurse, and a starry god of the deep among the 163 things nestled in this nocturne.

In order to reap the rewards of my work, you will need to do more than look at these reproductions. The most valuable advice I can convey is to look *closely* and to think about what you are looking at. Then, if necessary, look again, and the answer may well reveal itself. Never overlook the obvious. Children are especially able to see things so obvious they can prove invisible to a more sophisticated eye. They will tend to notice such things as weather, shapes, colors, and the initial letter itself.

To add to the fun of the pictures, things are not always painted to scale, and other things are often where you would not expect to find them under normal circumstances. Another item that may prove fruitful if examined is my signature on each painting.

If you identify all of the items I painted in the picture above, you will have a list of 202 words. Included are an iguana (do not ignore his footmarks), an Irish setter, an ironclad, an infantryman with an ingenious insignia, various interesting inhabitants of an inn, and an invalid near a suitable location.

Most art forms rely on the skillful unraveling of time. You become a passive passenger on a thin line stretched between "once upon a time" and "happily ever after."

A picture, on the other hand, exists out of time. It is a country that we can wander through at will, making our own pathways and discoveries—an endlessly fascinating terrain that surrenders new treasures to the observant at each visit. It requires an act of will to make this journey, and you cannot be led by the hand as in other media.

First you yourself must make the effort to see. OO

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WATCH

CONTINUED FROM PAGE 42

gions where clouds have formed cloudless spots just inches away might remain ozone rich. "On the other hand," Hofmann adds, "some of these variations could be due to advection of ozone-rich air from the edges of the ozone hole."

Rowland, the chemist who first predicted the destruction of ozone by CFCs, says the group's findings confirm his belief that chlorine is the major culprit in the formation of the ozone hole. "The chemical explanation of the ozone hole is the only durable theory," he says. "And Solomon's findings pretty much nail it down."

Rowland's comments have been widely quoted, and it's easy to get the impression that his is the only view. But there's an entirely different school of thought—one that doesn't get as much publicity but offers, in the minds of some well-established atmospheric scientists, an equally plausible explanation. Mark R. Schoeberl, a scientist at Goddard Space Flight Center, says the ozone hole above Antarctica has little or nothing to do with exotic chemical mechanisms involving chlorine from CFCs. His theory, based on photographs taken by Goddard's *Nimbus 7* satellite, is that unusual atmospheric winds created the hole simply by shoving the ozone around. Satellite photographs showing that ozone increases at lower latitudes just when the hole appears at higher latitudes bolster this theory, suggesting that the gas is simply pushed out of one region and into the next.

"The chemical theorists are also ignoring the fact that ozone levels have decreased at mid-latitudes in the Southern Hemisphere," Schoeberl says. "And their theories can't explain that."

Room for debate exists. But chemists and dynamicists agree that we'll solve the mystery of the missing ozone only after the upcoming Antarctic flights.

The linchpin experiment—the one that has the greatest potential for determining whether chlorine is eating the stratosphere—will be conducted by James Anderson, a Harvard chemist and atmospheric scientist who has built a career around making precise measurements of stratospheric gases. "Finding a combination of high chlorine and low ozone in the vortex," he says, "will be the smoking gun."

Anderson's experiment is only one of many experiments that will take place on the ER-2 next August. There will also be measurements made from the ground and on a DC-8, which will fly missions at lower altitudes. But it is understood that Anderson's measurements are by far the most crucial—so critical, in fact, that the ER-2 pilots have refused to fly the mission unless Anderson's experiment is onboard.

Anderson's Harvard office is tiny and not much used. He spends most of his time in the lab. He is at first remote, a bit withdrawn, but quickly warms to his subject, which is the mechanism by which tiny amounts of man-made chemicals can wreak havoc within the stratosphere. "The discovery of the CFC problem built the foundation for modern atmospheric sciences," he says. "Suddenly we had to predict the future, not just observe the present. This required laboratory-quality information gathered fifty thousand feet above the ground. The extensive preparation necessary to make instruments capable of making these observations is simply extraordinary."

Starting in the late Seventies, Anderson ran 25 investigations into the chemistry of the stratosphere using enormous helium balloons. From this work he knows that the stratosphere contains some chlorine monoxide, a product of the breakdown of CFCs by ultraviolet rays. The very existence of chlorine monoxide in the stratosphere is evidence that some breakdown of ozone is occurring, but it is not known whether there is enough of the chemical in the stratosphere above Antarctica to explain the hole.

Late last fall, amid growing concern, Anderson says, NASA asked him to abandon a project he'd been working on for years to address this crucial question. He was to ready a chlorine oxide experiment for the upcoming Antarctic flights. Anderson was given six months to build the instruments—not nearly enough time. The pressure, he says, was like nothing he'd ever experienced. A crack team of more than a dozen chemists, physicists, and computer scientists helped in the effort. And by the look of them, they haven't slept since they signed on.

The instruments this group has labored so hard to develop fit snugly into a pod on the wing of the ER-2. Air rushes into the measuring package, and as the air moves, its velocity is mechanically reduced in a two-step process from 200 to 20 meters per second. That air is then chemically combined with nitrogen monoxide, and the resulting reaction converts any chlorine monoxide (the product of CFCs) into chlorine atoms and nitrogen dioxide. Finally, this gaseous mixture is bombarded with a beam of ultraviolet light. UV causes chlorine to fluoresce, and the ratio of fluorescent chlorine atoms to nonfluorescent molecular scattering, related to the amount of nitrogen dioxide, indicates the amount of chlorine monoxide in the air sample. The pilot need only trigger a single switch in the cockpit to activate Anderson's delicate, computer-controlled machine.

According to Anderson, the answers gathered during the flight of the ER-2 will be definitive. A high level of chlorine monoxide combined with low levels of ozone would provide unambiguous proof that CFCs are poking holes in the stratosphere. The results will help us determine public policy and industry regulations for the next 50 years.

But regardless of the findings, Anderson is convinced that unleashing large amounts of CFCs into the stratosphere is playing with fire. "I'm shocked at the way the political community has responded to all this," he says, striding the few steps between an equation-splattered blackboard and a journal-covered desk. "Before the hole was discovered, hardly anyone was paying attention to the CFC issue. Now everyone is talking about destroying the CFC industry. It's this tottering between taking no action and rushing into a complete panic that I find so disturbing. As a scientist, I know we have to be careful about jumping to conclusions, but as a member of the human race, I feel very strongly that chemicals are guilty until proven innocent."

Robert Watson, acting program director of NASA's atmospheric research program and the master administrator behind the Antarctic experiment, agrees. Watson's Washington, DC, office is buried in papers, his phone rings constantly. A half-packed overnight case sits ready under a pile of charts and graphs. When asked whether the crayoned picture on the wall was drawn by his four-year-old daughter he looks confused before admitting that yes, it probably is. Barely a week goes by when Watson isn't lecturing or speaking in some far-flung corner of the earth on ozone depletion. The mission in Antarctica this summer is his baby.

But to Watson, it's worth the risk. "If we find that ozone is decreasing in Antarctica and that it is a precursor to global ozone depletion," he says, "then we will have to find a way to immediately get rid of CFCs for all but the most essential applications such as refrigeration."

Watson himself would ask the Environmental Protection Agency and the State Department to call an international meeting to negotiate a near-term reduction of CFC production. Mostafa K. Tolba, the executive director of the United Nations Environment Program, has already agreed to help organize the conference. Two separate pieces of legislation, put forward earlier this year in Washington by Senators John H. Chafee of Rhode Island and Max Baucus of Montana, would also gain in credibility. Both bills call for the gradual elimination of 95 percent of all CFCs, a move that would shatter the $10-billion-a-year industry. Chafee's bill calls for a ban on CFC-containing imports, including European cars and Japanese microchips.

There is, of course, no way to repair the ozone layer once it has been destroyed. But several alternative CFCs currently on the drawing board would be far less disruptive to the environment than existing CFCs. Du Pont, for instance, says that given the proper incentives, such as an impending international ban on current CFCs, it could have an alternative available within five years. The company's two most promising formulas, CFC 134-A and CFC 123, which tend to break down before they reach the stratosphere, drastically reducing their effect on ozone. These chemicals are currently being tested for both safety and effectiveness.

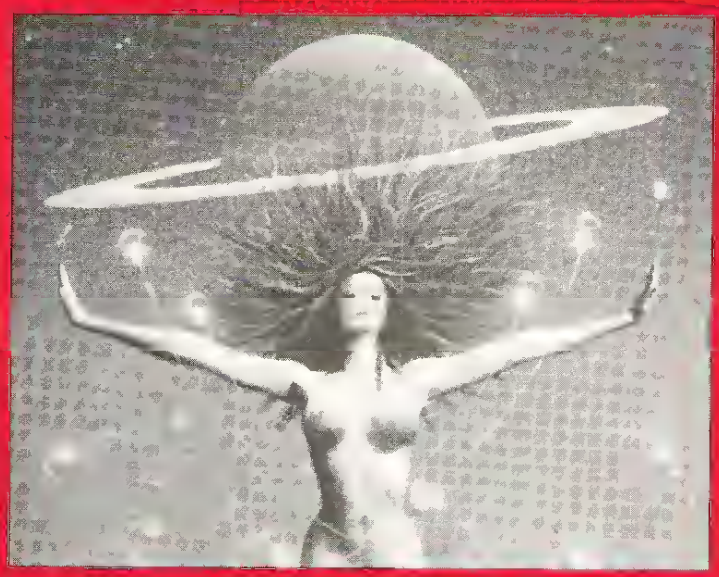
This month's flight into the ozone hole will help determine the future. But gathered together for coffee in the office of senior pilot Ronald Williams, the fliers are far removed from concerns of industry and state. They are hashing out the probability that they will return from the mission alive.

"This mission is more dangerous than anything any of us ever flew over Vietnam," says Williams. Williams wears boots, jeans, and a windbreaker. His handshake is firm to the edge of pain. Like the other pilots, he regularly spends six to eight hours behind a steering wheel flying miles above the earth. Some of these men have flown into the eyes of hurricanes; others have crash-landed in enemy jungles. But the Antarctic mission, they say, is special. "If you punch out over Antarctica," Williams says, "you are going to die."

Even so, none of the pilots have declined the assignment. "This is probably going to be my last chance to make my mark in history." Williams, fifty-two, chuckles, flicking a cigarette ash into the dregs of his third cup of coffee. "I'll be damned if I'll miss that." ∞

"The alien seductress had been tall and plump, with light, almond-shaped eyes and long, silvery hair"

ANTI MATTER



UFO UPDATE

Lots of teenage boys dream about sex But for eighteen-year-old Jose Inacio Alvaro of Brazil there were two major differences First his dream partner was a female UFO pilot Second, he met up with some UFOlogists who assured him that this interplanetary liaison had actually occurred.

Alvaro's story began on the evening of March 2 1978 right after a power failure immersed his home in darkness Stepping outside to investigate, he was amazed to see a giant UFO The moving object hundreds of witnesses later reported resembled a "gray-colored ball with luminosity around the periphery Said Alvaro, "It was huge and bright like the sun, I couldn t focus my eyes"

Soon after the UFO vanished, says Alvaro, the electrical power came back on Too excited to go home, he decided to take a bus to his father's house And he claims, after he arrived he looked out the window only to see the UFO again I felt dazed, the young man says "The light seemed to be telling me that I must walk and I accompanied it to the field"

The next thing Alvaro remembered was waking up in a field about a half mile from his father's house Already a UFO buff, he'd heard dozens of stories about UFO occupants abducting Earthlings for study, wiping out their memories, then returning them unharmed To find out whether that had happened to him, he looked up Brazilian UFOlogist Luiz di Rosario Real, who suggested hypnotic regression

The first session took place less than two weeks later, at the Federal Technical College in Pelotas, Brazil Under hypnosis Alvaro recalled a sexual encounter with an alien The naked seductress he recalled, had been tall and plump with light almond-shaped eyes and long, silvery hair Her breasts " he said "were fuller than the breasts of a female from Earth Her skin was very light " Alvaro literally quivered with pleasure as he told the story When he then repeated the tale for a second hypnotist soon after, Real and other local UFOlogists were convinced Alvaro insists that though he was emotionally confused after the sighting the hypnotic regression sessions put his mind to rest But what actually went on inside his head that evening remains a question for psychologists investigators have already explained what occurred in the skies.

By some quirk of geography, Brazil is half a world away from Plesetsk, a Soviet spaceport routinely used to launch satellites After coasting halfway around the earth Soviet rockets generally fire, pushing the satellites into distinctive, highly elliptic twelve-hour orbits Moments later as the exhausted rocket is coasting across the continent it vents its remaining propellant to prevent any explosions When these flights occur at twilight the propellant cloud is backlit by the sun which has already set for ground observers Those on the ground see a rapidly moving sphere, its edges brighter than its center because it is really only an expanding shell of gas At 10 00 PM on March 2, 1978, the communications satellite *Molniya 1 39* blasted off from Plesetsk A little more than an hour later it (and its venting booster) crossed the skies of Brazil. On the ground thousands of observers began freaking out, one worse than most —*JAMES OBERG*

BONES OF BIHAR

India has long been the world's largest supplier of skeletons for medical research and training. But last summer the Indian government banned the trade causing a severe shortage of skeletons worldwide. According to Dr. Dean Edell, editor of *The People's Medical Journal*, rumor has it that India put the lid on the industry because of "reports that children were being killed for their skulls. One report said that fifteen hundred children per month were being kidnapped in Bihar and that their skulls were sent to Calcutta for export to twenty-three countries."

Henry Galiano, owner of Maxilla & Mandible, one of America's leading bone shops, says the rumors are just that. "India is a civilized country—they aren't just a bunch of crazed headhunters," he says. "What's happened is that they are embarrassed by the scandal and want to preserve their image. It's a great loss. They were doing us a favor. Would you want to be operated on by some guy who's been playing with plastic for eight years? I wouldn't."

Obsolete though the industry may be, skeletons are in high demand today. Medical schools use the bones to teach prospective doctors important lessons about anatomy and surgical technique. Without real skeletons, plastic bones are the only option, but most doctors don't feel these are detailed enough. As it stands now, American physicians lack the technology and know-how to remove skeletons from bodies; specialized holding facilities and chemical solutions are required, and selling any part of the human body in this country is illegal.

"It would take a multimillion dollar grant to get the business going in the United States," Galiano says.

Skeletons used to be produced in the United States," he explains. "Manufacturers used dead prisoners and unclaimed bodies at hospitals, but this is no longer done. Today you'd have to convince people to donate their bodies for this purpose. Then you'd have to find someone who would do the job!" Galiano adds that the skeleton trade can be profitable. An average skeleton used to run $500, he says, but would be worth as much as $5,000 now.

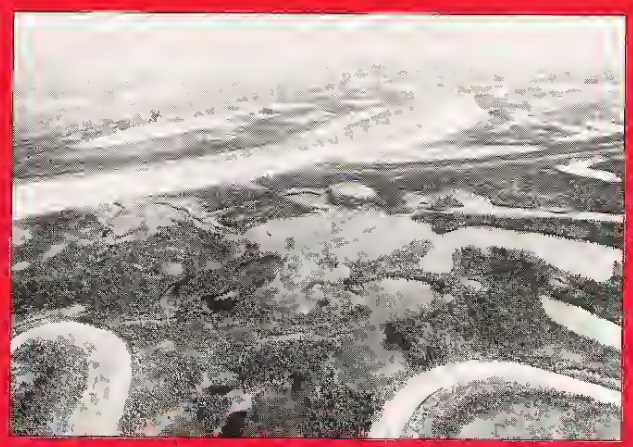
John-Bruce Shoemaker

It is life near the bone where it is sweetest.
—Henry David Thoreau

RIVERS OF MERCURY

In the second century B C Chinese historian Sima Qian wrote detailed accounts of a huge burial complex built for China's first emperor, Qin Shihuangdi, by 700,000 conscripts He included a cryptic description of mercury rivers "created and made to circulate mechanically"

Although rivers flowing with quicksilver have long been considered a fabrication based on myth, archaeologists excavating near the



tomb of Qin Shihuangdi recently found evidence that seems to back up Sima Qian's ancient tale According to the *Guangming Daily*, the official Chinese newspaper an analysis of soil surrounding the burial palace showed inexplicably high levels of mercury

"Sima Qian, the most famous of all Chinese historians, is regarded as a scholar of the highest standing," says Irwin Hyatt, associate professor of Chinese and Japanese history at Emory University "But for centuries his descriptions of rivers of mercury and other things supposedly in the first emperor's tomb were considered myths. Excavations in China in recent years, however, have tended to bear out much of what he said"

According to the *Guangming Daily* report, that's one reason why archaeologist Yuan Zhongyi is *cautious* about probing the tomb of Qin Shihuangdi Sima Qian warned that along with flowing quicksilver, the place was booby-trapped with "mechanically triggered crossbows set to shoot any intruder"

"I suppose if you see one thing borne out, like the so-called mercury rivers," Hyatt comments, "you tend to worry about some of the other things that we've long thought were just fanciful'

—Sherry Baker

"How did the great rivers and seas gain dominion over the hundred lesser streams? By being lower than they"
—Lao-tzu

LISTER WARD

Modern medicine supposedly owes its squeaky-cleanliness to Joseph Lister (think *Listerine*), the Victorian surgeon who first used carbolic dressings to keep wounds from becoming infected But a new book from England reveals that Lister himself (right) was a walking sepsis who never even bothered to wash his hands before an operation

Writer Martin Goldman relies on the written records of two of the good doctor's patients to paint a lurid picture of the conditions in the *Lister Ward* (the title of Goldman's book)

Ernest Henley and Margaret Mathewson, both of whom suffered from tubercular bone infections and both of whom spent months under Lister's care at the Edinburgh Royal Infirmary, described the surgeon's bailiwick as positively medieval. Rooms were tremendously overcrowded with patients—even infected patients—forced to share

beds Sheets soaked with pus and blood routinely went unchanged for days

Through this hospital hell the witnesses wrote, strode Lister himself, focusing myopically on his surgical dressings while all around him the microbes partied in the general filth In fact, Goldman points out, it was not until the arrival of a cadre of nurses trained by Florence Nightingale that Lister's stomping grounds began to truly clean up

In the end, though, Goldman comes down clearly on Lister's side The surgeon he notes was 'undoubtedly a very great man, for he brought science back to medicine'

—Bill Lawren

I became interested in syphilis when I worked for a time at a mental hospital full of GPI cases I discovered there was a correlation between the spirochete and ad talent"
—Anthony Burgess

"Man is wolf to man."
—Robert Burton

ANTIMATTER

SIGNS OF STRESS

Ravaged by anxiety? Plagued by insomnia? Too jittery to work or even eat? The problem could be your sign. According to a study done last year by a market-research firm in Australia, some astrological signs literally invite that most wrenching of conditions, stress. Aquarians, Geminis, Virgos, and Cancers are almost stress addicts, the survey showed, while Pisceans, Scorpios, and Tauruses can count on lives of tranquillity and peace.

Enter Kathleen Johnson, a Vermont astrologer who happened to read these results in *The National Enquirer*. Using data from her own booming practice, Johnson took the conclusions further still. Rating each astrological sign as it relates to others, Johnson developed what she calls a stress matrix—a gridlike chart that determines which marriages and friendships will be most harmonious and which most stressed.

"If you're a Taurus going with a Gemini," she explains, "you'll have a partner who can deal with a lot more stress than you. But if you understand that she likes to live on the edge of a precipice while you want your rent paid eight months in advance, it just might help you to get along better."

Johnson found, for instance, that any sign matched with a Pisces or Scorpio would have a low astrological stress index. Most signs matched with an Aquarius make for endless strife. And marriages of Aquarius to Aquarius are doomed. With such unions yielding the unbelievably high stress index of 78, Johnson says, they are likely to end in bitter fights and brawls.

"I think we're so preoccupied with stress, strain, and all the things that make us feel comfortable and uncomfortable," she adds, "that knowing your astrological stress level is extremely important."

Johnson's new book, *Celestial Bodies* (Simon and Schuster, 1987), describes how astrology relates to emotional, mental, and physical health. "There are those who say that you can't mix astrology with anything," she says. "But I feel that we should all work together. If I know something as an astrologer that can help you as a doctor or psychotherapist, why not?"—Joanna Torrey

"The mystic sees the ineffable, and the psychopathologist the unspeakable."
—W. Somerset Maugham

"No one easily survives love, neither the lover one has, nor the lover one has not, each breaks down in the red smoke blown up of the day when all love will have gone on."
—Galway Kinnell

NESSIE GNARL

The people who pursue the Loch Ness monster are generally a comradely bunch who see eye to eye on the important issues of their trade. (If you believe Nessie exists, after all, that doesn't leave a great deal to fight about.) But in recent years that has changed.

Seems the International Society of Cryptozoology (ISC), whose membership includes most of the "good old boys" among Nessie watchers, is sponsoring a big two-day conference this summer in Edinburgh. Fine. But now along comes maverick cryptozoologist Jon Erik Beckjord to announce that he will hold an "alternative" conference at virtually the same time and virtually around the corner.

Beckjord's beef is that only one of the two days of the ISC conference will actually be devoted to discussion of Nessie, the second day's program will shift to "crypto zoological cats," the weird and previously unclassified pumalike creatures that have been reported from time to time. Perhaps even more to the point, Beckjord says that the ISC "hates my guts. I've done significant research, and they won't even answer my letters." (He once filmed a "large and vigorous object" swimming furiously under the murky waters of Loch Ness. He also filmed what he believes is a "big-breasted female Bigfoot with her young.")

The ISC, which has apparently tangled with Beckjord in the past, is now maintaining an arch and official silence. "I have no comment whatsoever," says ISC secretary J. Richard Greenwell, "on anything Mr. Beckjord has said in the past, is saying at the present, or will say in the future on any subject whatsoever." Stay tuned.
—Bill Lawren

"In each human heart are a tiger, a pig, an ass, and a nightingale. Diversity of character is due to their unequal activity."
—Ambrose Bierce

STARDUST

CONTINUED FROM PAGE 46

grinding of gear teeth, a shudder Herman could feel through his feet—he had the impulse to run. It was a peasant reaction, and he fought it. After Labor Day Shell Island reverted to the elements. Property rights were suspended. Despite all the signs, he had as much right to be where he was as the wind. Those thoughts gave Herman a flush of courage, enough to hold his ground. The rain came harder. There was a growl of thunder from over the water.

Now the moat was bridged by a gangplank of wood and metal. At its root there appeared an arch like the mouth of a shrieking cartoon character. The Castle Avnolet was sticking its tongue at Herman Horman. He was being insulted by the pile of transplanted rocks. For a brief moment his detente with the fates came unhinged. He stuck his tongue back like a boy wagging at a playmate. Herman stood there amazed at how close his species was to the grandfather apes.

Just as he was about to turn and go on his way, a woman appeared at the castle's entrance. He saw immediately that she was a good fit—the right height, the right width, the right age. He always measured women first by the way they might jigsaw in embrace. She wore brown leather pants and a russet wool jacket with a large collar that cradled a face set with huge eyes and topped by a mop of brown, frizzy hair. As she came closer he heard her high boots crack on the wooden ramp. Her movements echoed breeding. Herman saluted with a casual wave. She waved back. When they came face to face, she said, "Hello, strange man with the Heidelman."

"You know about my telescope?

"You aren't the only trespasser on Shell Island. I see you on your deck at night browsing the stars. Are you some kind of astronomer, then?"

"No astronomer. I am an artist named Herman Horman. No, don't say, 'That name sounds familiar,' because you've never seen it on a painting. I sign my commercial work with made-up names, and my own masterpieces have never been exhibited."

"Herman Horman? That name doesn't sound familiar. I'm Madeline Avnolet."

"Avnolet? Then you're not the caretaker."

"The castle is mine, Mr. Horman. By accident of birth."

"Happy accident."

"My grandfather bought it and mailed it over here. My father added a few touches of distinction, like the television room and me. My mother ran away with a Sioux Indian activist named Fat Otter who she met while doing good works. So when Daddy died in a helicopter crash, everything came to me. Please don't hold it against me, Herman Horman."

"I'll certainly try. I never met a castle owner before."

"The first time is hard. I don't envy you."

"Should I bow and scrape?"

"That's the least you can do. And you can come in out of the rain for a drink. It is dismal out here."

"Three days of dismal."

Herman followed Madeline Avnolet along the wooden tongue to the entrance arch, feeling like a tourist on parade. He looked at her straight back and round rump. She was a bit stringy but nicely turned. Her legs impressed him most, long as highways.

She led him through a barn of a hall, then up fifty granite steps to a balcony. They turned off the balcony and went down another hall lined with marble. Then up more steps, around two turns, down a short staircase, through a greenhouse filled with flowering plants, past a large swimming pool, and into a room paneled in rosewood, where a fire crackled at logs thick as thighs. The room was filled with soft chairs and deep sofas.

"A nice place you've got here."

"It is cozy. What's your pleasure?"

"The castle rested like a lump on the highest rise of land with a view of everything. He looked up to the towers. A curl of smoke twisted from one chimney. Someone was in residence."

"Better weather. Short of that, maybe a glass of wine."

Madeline went to a cabinet filled with bottles resting on their sides. She picked one, slid it out of its crib, and opened it with a giant corkscrew crowned with the head of a panther. Herman got his wine in a heavy goblet initialed with a curly *A*. While he sniffed the bouquet, she poured herself Chartreuse. Her pony glass was of delicate crystal, with a stem no thicker than a reed. Its *A* was etched inside a tiny shield.

"To fair and warmer," she said.

They toasted fair and warmer. His elephant glass and her insect glass clinked a pure note. They drank. Herman sipped. Madeline gulped her Chartreuse. That surprised Herman, who knew the green sap should be savored, not swallowed like an oyster. Then Madeline hurled her glass into the fireplace, where it disintegrated to splinters. "Luck," she said.

"You wasted a perfectly good glass," he said before he could stop himself. That glass would be thirty dollars at Steuben.

"Now you waste a glass," Madeline said. "Go on."

"Me? No. I couldn't."

Madeline smiled. Herman downed his wine, then stood and faced the fireplace as if it were a catcher giving signals. He pumped, shook his head no, shook his head yes, raised his left leg, reared back, and threw the goblet. It missed the fireplace but hit the mantle like a bomb.

"I never saw anyone miss an entire fireplace. A very large fireplace."

"I'm out of practice," Herman said.

"We'll keep trying until you get it right."

Madeline brought him another goblet of wine. This time she drank Grand Marnier from the bottle. She led him to one of the sofas. It must have been made of cashmere. It was like sitting on a chubby baby.

"So," Herman said, "Comfortable. Very nice. The queen's chamber. I could get used to this."

"Could you? There's responsibility being lord of the manor."

"I knew there had to be a catch. Tell me, Madeline, do you live here alone? I mean, except for the cleaning lady."

"I'm not a person who needs people very much. I love being on Shell Island this time of the year."

"The same with me. The same. I come back year after year. My friends tell me, 'Herman, go other places, see other things.' But I come here. I'm still a renter, though. I should have bought years ago when it was possible. But now? Forget it. You're lucky your people knew real estate. Is that the kind of thing you say to a lady who owns a castle?"

"What do you paint, Mr. Horman?"

"Herman. What does Herman paint? That's a hard question to answer. For a living I paint things that sell products. Girls with dimples who twirl batons. Homos in cowboy suits. Boxes, bottles, appliances, you name it. For salvation I paint the Feinbacher Galaxy. That's—"

"Discovered in 1525 by Zoltan Feinbacher?"

"No, not that one. Of course that one. How in hell do you know about the Feinbacher Galaxy?"

"Come with me," Madeline said.

"You mind if I carry my drink?"

"As you wish."

Herman went through more corridors, rooms, foyers. He went up so many steps he lost his breath. At the end of the journey he found himself in the most beautiful room he had ever seen.

"This is how I know about the Feinbacher. Grandfather believed in his horoscope. He kept astrologers."

The room was a circle with a glass roof. Through an opening in the glass a polished brass tube protruded up into a closed dome. The tube rested on spider legs set in a heavy base. Star charts had been carved into the room's walnut walls, then filled with silver. Zodiac signs in gold against blue enamel decorated the curve where those walls met the transparent ceiling. A huge bookcase held a library of ancient volumes that could have been bound with the pelts of dead geniuses. A globe of the heavens split like an egg held a desk fashioned into some kind

of mythical beast. A chair covered in dark green leather faced the desk.

"You have your own observatory," Herman said, his awe evident.

A house is not a home without an observatory. The dome up there parts. If the sky clears up tonight, I'll show you."

Tonight? Herman did not miss the significance of her *tonight*. He was being invited to stay, or was it assumed?

Madeline: I certainly would like to see that. But not on the first date. I might begin salivating or foaming at the mouth."

"It's just a great big wonderful toy. A toy is a toy, Herman."

"A toy? That scope probably brings Feinbacher right into a person's lap. No toy. A blessing. I can't believe what I see."

"Well, you can play with it anytime you want. The barometer over there is rising, and the wind is blowing from the west. The mess will probably clear out in a few hours. Meanwhile, I thought we might have ourselves a light supper."

"I accept. I'm hungry as a horse. Thank you, your majesty."

"Potluck, though."

"You are talking to a man who thaws his food. Anything would be fine."

"Then why don't you stay up here and enjoy yourself while I go down to the kitchen? I'll call you when I'm ready. There's an intercom on the desk."

"No. I'll never find you again. This house is a maze. I have no idea where we are."

"Trust me."

Herman sat in the green leather chair, absorbing emanations from the Avnolet observatory. Her grandfather kept astrologers? He believed in his horoscope? No wonder. That telescope made the Heidelman into nothing. Focusing on the Feinbacher with such magnification would be the difference between having a model sitting in the studio instead of glimpsing a nostril, a breast, a toe, a lip through a smoky tunnel.

A few nights of such inspired observation could catapult over years and trigger luminous insight, maybe even revelation. Herman felt himself sweating.

There were dangers. Madeline Avnolet might allow him a peek under the skirt of the universe, then lose interest and withdraw her magic. What then? After that, working with the feeble Heidelman would be impossible. Everything would change. Terminal discontent would be the only inheritance. It would be wiser to say thanks but no thanks to the lady who threw crystal into the fire. He might be next, smashed against stone while flames fed on his entrails.

His urge was to get out and go home, to follow the instinct of flight he'd felt when the moat first groaned. Herman Horman had no business in that room.

The intercom buzzed like an arrogant bug. He let it buzz three times before he picked up the receiver.

"Ready when you are, Herman. I hope you like simple."

"Simple is a gift."

"Then come and dine."

"You come get me. Or send a Saint Bernard. I have a terrible sense of direction."

"Just go out into the hall, and all will be perfectly clear."

"Ah, rich, rich, rich." Herman said when he followed her instructions. In the corridor outside the observatory a trail of tiny lights flashed along the wall. The whole castle was mapped by light. Madeline guided him by programming his course.

Herman felt giddy as he went along, up and down and around, until he heard music. He thought to himself, "Not bad for a rainy afternoon." The lights stopped at a door. The music came from behind the door. What would the dining room be like? Herman envisioned a forest of chandeliers and utensils of heavy silver. He conjured masses of flowers and silk napkins embroidered with curly *A*s. Near the door he smelled delicious odors. Potluck?

He turned a knob with a lion's head and swung open the door inlaid with mandalas. Herman found himself in a bathroom large enough to hold whole families. Madeline thought of everything. She knew instinctively it was his ritual to pee and wash up before taking food. She knew he would never *ask* where the toilet was, under such circumstances. She had provided.

"Herman saw that a star was missing. There was a space that broke the visual harmony. It was as if Garbo smiled with a missing tooth or a word had been deleted from familiar poetry."

Herman noticed that the tempting smells were not from cooking but from perfumes. The bathroom was filled with a fine mist that rose from a steaming tub set on an onyx throne. White Turkish towels hung over a warmer. An emperor's bathrobe was also kept warm. Maybe Madeline was a cannibal. He could cook in the tub, basted by herbal perfumes, and nobody would ever know. His bones could be discarded in the sea. He found the toilet behind a Chinese screen. Then he washed his hands in a sink shaped like a swan.

Another door opened. Madeline stood holding a martini. "I thought you might want a hot bath to wash away the mildew. Here, I made this for you."

"A bath? Before supper?" He always bathed after dinner or took a quick shower in the morning.

Madeline left him alone to decide. He tasted the icy gin. Then he undressed quickly and looked around for hidden cameras. Maybe a whole group of castle dwellers was waiting in tuxedos for the chance to laugh at his white, skimpy body. When he got into the tub, small waves moved the water. His weight switched on some automatic tide. He watched the waves roll along and break against porcelain shores. After his bath Herman put on the velour robe with a large *A* on the breast pocket. *A* for *Avnolet*, for immense effort in the pursuit of happiness. Smelling like a garden, Herman went through the door where Madeline had appeared.

He was not in a dining room. He was in a bedroom. He saw a bed for giants covered by a canopy of frills and tufts. Near the bed was a bidet trimmed with fleurs-de-lis. In the space between the bidet and an armoire covered with pictures of songbirds was an elegant golden table draped with a paper cloth printed with comic book images. Herman recognized Bugs Bunny, Batman, Superman, and The Human Torch. The table was set with plastic party plates, knives, forks, and spoons. There were Wonder Woman wax cups. Then there was a centerpiece, a black iron candelabra hammered clean of sin—monastic, stark, and strong. It held seven white candles in tulip-shaped cups. The candles burned with flames that waved like swamp grass.

Another door opened into the room. Herman's eyes fastened on a rolling cart that held the potluck. He saw steamed lobsters, a dish of pink crabmeat, plates holding clams and mussels resting on platforms of chipped ice. There was a glass salad bowl with the engraved *A*, filled with endive, romaine, tomatoes the size of marbles, and mounds of mushrooms. At the cart's base, on a small shelf, two silver buckets held magnums of Dom Perignon.

"Are you pleased, artist?" said Madeline.

"So this is your light supper. What do you eat for breakfast? Unicorn?"

"Herman, please take your eyes off the food for a second."

"I can't. This is the kind of thing I taste on bicentennials. Should I eat it or frame it? And the decorative mix. I mean, the pop art contrasted with the baroque and medieval. Red Grooms meets Vivaldi. And there's the bed. Oh, yes, the bed. And the bidet. What a nice luncheonette."

"Don't be hostile."

"Hostile? Me? No, just edgy. Edgy. I love surprises."

"You haven't looked at me."

Herman peeled his eyes from the delectables and saw that Madeline Avnolet was naked except for a black band around her waist. From the band hung a spoon of translucent blue.

"I know. You're nude. Except for the spoon."

"I am glad you noticed."

"Madeline, don't make me feel like an asshole. Since I came here it's been one thing after another. I'm resilient. But first meeting you on a damn drawbridge, then the observatory, then the bath, and now the food, and you standing naked dangling a spoon. Everything is anticlimactic at this particular

moment. Is the Vienna Boys' Choir next?'

'My timing is bad. Should I slip into something less comfortable? Would that relax you?'

"I don't know. Let's drink some champagne and talk. I was expecting a quiet, rainy day. And yes, if you're wondering, I like your body. It's a beautiful body. Just the kind of body I enjoy. There's a softness disciplined by form. The curves and angles clash. The candles make you shimmer. Of course I like your body."

Madeline sat on a velvet-covered chair. Herman sat across from her, opening a Road Runner napkin, trying to focus on her face.

"So talk, Herman. Tell me why you artists clip off your ears."

"The better to see with. Now do you mind if I go ahead? I never saw so many lobsters in one place. A cluster. A surfeit of lobster. None of this is happening. I'm home, asleep."

'Try the salad. And the little bowl is cucumber soup.'

"Cucumber soup? Why not?'

Herman filled a plastic plate. Madeline watched him eat. He stopped eating.

"I'm sorry," she said. "It's just that you're so hungry."

"What about you? Aren't you hungry? Supper was your idea."

'I eat very little. But I will nibble."

She reached under the table and somehow detached the sapphire spoon. Herman watched her take a few flakes of crabmeat and touch it to her lips.

'Did you eat cucumber soup as a child, or did they spring it on you later?"

'We ate cucumber soup from July fifteenth until the first of November.'

'I'm not criticizing, Madeline. And I will try some if you don't tell me the ingredients. I don't want to know about ingredients. There's always something that starts with a *y* or a *z* that makes me want to throw up. Yogurt. Zucchini. Barf.'

'There are no ingredients."

'Good news. But you're not taking in much nourishment. Are you anorexic? No. I can see you're not. And you have your own special spoon, and I get plastic. You get... what is that?'

'Sapphire. My grandpa gave it to me when I was born."

'A jewel for a baby spoon. Sweet. So use it. Keep me company. I feel like a hog eating alone.'

'Don't push at me, Herman.'

Herman shrugged and dipped a shrimp the size of a comma on a billboard into tangy red sauce. A drop of sauce spilled on the white robe. He dipped his napkin into cold water and dabbed at the dot.

"Forget it. Please.'

"I am such a slob. I always dribble. I should sit in a high chair.'

"Here, let me help."

'I suppose you have a laundry in the basement staffed by Oriental philosophers. Or is the robe disposable?'

Madeline got up and came around the table. She took the wet napkin from Herman's hand and began to rub gently at the spot which was near his navel. He chewed a mouthful of clam while she worked. He swallowed the clam down with champagne, blotted his lips with another napkin, Woody Woodpecker this time, and felt a flush of heat between his legs. It had been spring since he last touched a woman and years since his navel was massaged. His erection surprised him as much as it must have surprised Adam. He jumped from the chair, trying to conceal the bulge.

"So what's your game? Pick up a stranger, fill him with phosphorus, give him a little rub, and zap him into the sack? Is that it? It's no accident that you're stark naked, is it? Or am I leaping to conclusions?"

"Come back here."

"Miss Avnolet, I am no slut. And neither are you. Look at the advantages you've had. The best schools, the genes of conquerors, your own castle. And see how you behave. We might have had a real relationship. That's the pity.'

'Shut up, star man. Cease and desist. Just stop it now and leave my castle out of this. We are having a relationship. But it's already half through October, and your time is running out. We have no time for the usual preliminaries. And yes, I am rushing things. And I have been lonely. I am lonely, Herman. I like you. I want to lie with you and be touched by you. I want my nipples to turn to pebbles and feel you at my breasts. I want you to come inside me and gush. That's what I'm hungry for. Now, should I get dressed and wait around for you to undress me, or should we go to bed? Which?"

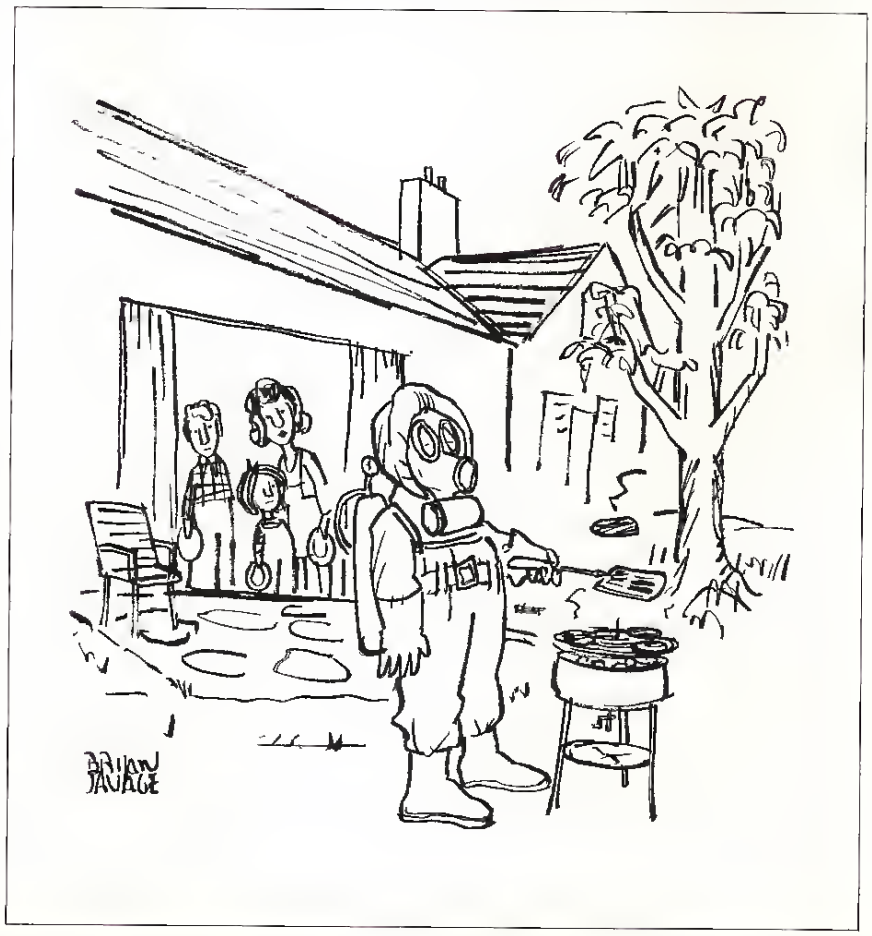
'When you put it that way, I suppose we can wait for coffee and dessert."

Later, still in his robe, Herman followed lights back up to the observatory. Madeline was asleep. He kissed her cheek before he left the room. She had switched on the trail of light and told him which buttons to press to make the telescope work.

The sky had cleared. When he manipulated the right controls, the shell guarding the scope parted with a whoosh. The scope rose on hydraulic legs and turned toward the Feinbacher. Before taking his first look he hesitated, remembering earlier qualms. First he put his eye to the eyepiece, keeping it shut tight. Then he opened it quickly.

There was the Feinbacher: the peas and pearls turned to grapefruits. Melons. Herman gasped. Instantly he saw things he'd never seen before. Moons, rings, flares, colors, shapes, shadows, nooks, dents. He always heard music when he looked through his Heidelman. Now the music boomed. He walked through the Feinbacher like a street kid carrying a radio. His right hand curled around a nonexistent paintbrush. He was in a creative spasm. Through the pain he knew he had never been so happy.

Then Herman saw that a star was missing. In the left quadrant of the fourth grid there was an empty space that broke the visual harmony. It was as if Garbo smiled with a missing tooth or a word had been de-



The Artist

leted from familiar poetry *To be or to be* Herman blinked and pressed more buttons The Feinbacher came into sharper focus, but the space was still there He laughed For all its majesty the castles telescope was defective The problem could be as simple as a stray raindrop or bird droppings on the lens But the little Heidelman never deleted what might be a world The Heidelman's lens could be wiped with optical paper or even Kleenex To clean the monstrous Avnolet eye would take a mop Space or no space the rest of the picture was astonishment Herman stayed up there until dawn's early light

He went back down and got into bed Madeline was a perfect temperature He felt himself warming like a frog on a lily pad They made gentle morning love Then Madeline brought Herman personally squeezed orange juice thick black coffee, a croissant, and cherry jam

'Only in America,' he said 'Lying here with an Avnolet If you are an Avnolet I didn't ask to see your birth certificate If my mother could only see me she should rest in peace And your grandfather may he corner every market in heaven What would the old man say?'

'Buy soybeans that's what he would say He said it once during a seance A spirit medium contacted his shade, and that's what he told my father'

"Soybeans went up correct?'

"They rocketed."

"I knew it Madeline this has been the optimum night of my life As the kiddies say awesome

"Do you mean that?'

'I do And yes, I'll call you in the city If you want me to Do you want me to?"

Madeline cuddled closer Stained glass windows turned her breasts rosy pink Herman nearly fainted from a surge of love as he reached out to her

"Tonight you'll come over to my place I'll retaliate with stuffed eggplant, my specialty My dish."

"Don't tell me the ingredients.'

'Be there at seven We have better sunsets than you have here at the castle We'll have drinks carrots, and celery chunks at Villa Horman For dessert we'll lick rainbows And don't bring anything but yourself This one is on me I'll pull out all the stops Money is no object.'

"I'll be there, darling.'

"I know, darling I know.'

"Are you excited about us, Herman?'

"Very excited about us We have real potential even if you do come from the wrong side of the tracks I'm a democrat I can look the other way.'

"I would hate a mere castle to come between us."

"I wish I could write," Herman said "We are a major motion picture.'

"Seven," Madeline said while the moat was bridged, and Herman pranced out of Castle Avnolet like a carriage horse

Walking down toward the curve of beach, Herman Horman had a strange sensation He imagined a long thick rubber band fused to his flesh and stretching around the castle's highest tower He'd had that feeling once before He was nine leaving New York for the first time for a week in the country The Fresh Air Fund sent him to look at a cow As his bus moved across George Washington Bridge toward New Jersey he sensed an elastic that linked him to the Empire State Building A week later he snapped back to the city Here was the feeling again this time mixed with an emotion Herman had to recognize as joy

He shouted greetings to a heron He was making *a joyful noise* Herman was not a man who made many joyful noises The whole idea of joy made him edgy Joy was a poison apple Horror was always taking on the guise of happiness For Herman the worst thing would be to die laughing When intimates accused him of being depressive he told them he was a pessimistic optimist and it was true He drew the freckled faces of impossible Hallmark children for a living His work sold products Something in him still longed for a cookie jar The best idea was to be very careful, to expect quicksand but to seek messages from the stars His usual joyful noise was a suspicious growl Here he was greeting indifferent birds and so he had to consider the possibility that he truly was *in love*

Herman began to jog along the damp sand He had not been in love since adolescence He had fallen for a serious girl named Margy, who gave her virginity to his best friend While Herman read manuals about erogenous zones his best friend jumped in Since then he had *liked*, felt *gratitude*, *warmth*, *compassion*, *lust sensuality*, *longing* but never love Now the image of Madeline Avnolet throbbed inside him He felt as if he had swallowed her along with her lobsters clams shrimps cucumber soup and wine He tried to separate her from the castle, the telescope stained glass windows But she was those things Herman fought his first impulse to get home to his pads and canvas The fingers of his right hand still curled and twitched to record what he had seen of the Feinbacher But instead he stopped at the Shell Island Market and bought his eggplants chopped chuck, an onion, a green pepper rice and spices He chose a package of frozen broccoli two seeded rolls and a packaged apple pie With his last coins he bought a red candle

When he got back to his house he felt rabbits, foxes, deer squirrels judge his return Even trees watched He had been gone all night He disrupted the October environment If he could, he would have told the witnesses what happened but they wouldn't have believed him A clerk from the market maybe But Madeline Avnolet?

First he put the food away then began sketching He drew the Feinbacher's stars in majestic proportions In the left quadrant of the fourth grid he added the missing star

Out on the deck he fondled his Heidelman The scope seemed pathetic like com-

ing home to a friend hopelessly outgrown like visiting a room best left to memory. What I have seen, Heidelman. What I have seen. Not that I feel any less affection for you, wonderful instrument. But there are entire realms you can never share. A man must cross horizons to discover new horizons. Don't worry. I won't sell you. But you may go into storage. You may become nostalgia.

"She has deep feelings for me, Heidelman. A man can interpret the language of moans and groans. She comes packaged with millions. And an equipped observatory. Do you understand what that could mean to me? A slow walk around the universe. No interruptions, Heidelman. Endless hours. Not to mention family connections to the best galleries and museums. My father used to say, 'Herm, what's wrong with falling for a rich lady?' I winced when he said it. Because he was telling me not to fall for poor. But this is different. The woman is nice. A pleasure to look at and a comfort to lay with. She warms me, Heidelman. Give me your blessing, premature as it may be. Who knows, we may never go back to the city. To that place of blank skies. Don't laugh, Heidelman. It could happen."

By the time Madeline came, Herman had the fire going and his table set. He poured glasses of wine. His eggplants were bubbling in the oven. His radio played Mozart. When he heard the bell from her bicycle, he lit the red candle. This was the package he came in, take it or leave it. "If she walks in here and vomits," he said to the air, "then we'll be good friends."

At the door Madeline handed Herman some wildflowers. They kissed. He put the flowers in a jar, then took her out to see the orange-gold sky. They made love on the grass while the eggplants baked.

"You know what we remind me of?" Madeline said. "Bread in an oven."

"The rolls. I've got to warm the rolls."

"My object was not to remind you to remember to warm the rolls."

"I forgot salad."

"Not yet."

"Madeline, we are being watched by animals. They've never seen this side of me. I've got to live with these creatures. Please show some restraint."

"Herman?"

"What?"

"Nothing."

At the table Herman served his hot meal. He lifted his wineglass, which was the same as his water glass.

"To us," he said.

"To us," Madeline said. While she drank she reached into a leather purse and took out her blue spoon.

"I have spoons," Herman said.

"And I have a few quirks."

"How come your grandpa didn't give you a complete matched set? At least a fork."

Herman ate with his usual gusto. He watched Madeline touch her spoon to the rice and find a few grains.

"I slaved over this dinner. This is no potluck. Don't do this to me."

"I'm a puffball, Herman. I've got to diet. Be supportive."

"What puffball? You have a perfect figure. These eggplants come from a genuine garden. The chopped meat is chuck. I thawed the broccoli. Come on, this is a celebration. A party. It's our anniversary."

"I can't explain it, but all I can think of is holding you. You're my nourishment. Let it be."

"If I am preferable to a baked, stuffed eggplant, then I accept that graciously. You're crazy, you know that? Let's go to bed."

Madeline told no lies. She bit at Herman's ears, chewed his mouth, took his honey, found vitamins he didn't know he had to give. Herman and Madeline flowed in and out of one another like breaking waves. After, Herman had coffee and apple pie. Madeline had tea, no sugar. He took her out to see the Heidelman.

"My observatory. Have a look."

"That's very effective. It has more power than I would have guessed."

"The wind scattered sound when he called her name. So he ran toward her. When he got close enough he saw that she held her hand up toward the sky. Her hand held the blue spoon."

"Don't patronize me. If you feel contempt, show it."

"I love your Heidelman," Madeline said.

Herman took a peek at the Feinbacher. No more melons. The stars were the familiar grapes. He squinted. In the south quadrant of the seventh grid another star was missing. He slapped the telescope as if it were a bad puppy. The scope vibrated the picture. He looked again. Two stars were gone.

"Is something wrong?" Madeline asked.

"With my head. I'm seeing things. Or I'm not seeing things I should see. Stars are vanishing from the Feinbacher."

Madeline laughed. Herman scowled at her, then began to giggle himself. They laughed together for five minutes.

"I know you're a night worker. Are you planning to work tonight?"

"Yes, definitely. I missed four nights already, what with you and the rain."

"Suppose I sulk."

"The meter is running, Madeline. As you so frankly pointed out, October is half over. I have less than two weeks left."

"Not so."

"Meaning?"

"Meaning what you already know. That you'll stay on Shell Island. Meaning that when we aren't conjugating the best verb you can spy on your Feinbacher and make as many pretty pictures as you want. Meaning that you have a patron."

"So fast, Madeline. Are you sure?"

"I am sure, Herman. And you? Are you sure?"

"I think I was sure when I first saw you clomp across your moat. Nobody told me I would go for a girl with a moat."

"Will you marry me on a beach?"

"I hate being married on beaches. But I'll make an exception for an Avnolet. Marry me on a beach, the beach of your choice. Where will we live? Here or at the castle? If you insist, the castle. I hate breaking the news to my landlord, but if I must, I must."

"You bastard. You want me for my material possessions. You don't love me."

"I do. I'll prove it. Tonight I won't work vertically. I'll work horizontally. Come, or I'll start without you."

"Kiss me a lot."

"A lot. Come, Madeline, be my valentine. I never had a valentine, and I always wanted one. Like I always wanted to pull a hamstring or have arthroscopic surgery like the jocks. Now at least I have a valentine."

"I love you."

"I love you."

"I love us."

Herman woke near four o'clock. He moved his arm toward Madeline and felt empty blankets. He got up, put on a pair of shorts, and went searching for her. She wasn't in the house. He went out into the waning night. She wasn't on the deck or near the walk. But her bike was still in place.

Herman was not concerned. A woman like Madeline would go down to the beach on impulse. She probably needed to cool. So much pleasure delivered so quickly required time to absorb, like water after a downpour. If Madeline had to be alone, so be it. He decided not to go after her. If she wanted a taste of loneliness to measure their closeness, then she deserved her solitude. It was holy.

So instead of pursuing, Herman went to look up through the Heidelman's short tube. And there was the dependable Feinbacher, fainter with the oncoming dawn but still very visible. The two disappeared stars were still absent. Could there have been a vast explosion eons ago to pock the Feinbacher's enormous cheek with black holes? The rest of the stars seemed intact. Or were they? Herman zeroed in on one fleck at the galaxy's center. It flickered like his red candle, sputtering at life. He knew it was dying. He was watching a star die. Standing in his shorts, Herman saw the final battle. He shuddered. The star was fighting like an insect in a web. But it grew dimmer. This had to be studied. This was for the other telescope.

"Madeline?"

Herman ran down the driveway and onto the road. He cut through brush and headed for the beach. He knew she would be some-

place down there. And he was right. Past a large dune he could see her silhouette against a bright moon. The wind scattered sound when he called her name. So he ran toward her. When he got close enough he saw that she held her hand up toward the sky. Her hand held the little blue spoon. She brought it to her lips. Then Herman saw a shimmer of light ripple through her body. He knew she was eating a star.

"Madeline?"

She turned and put her hand over her mouth like a child caught with candy.

"Herman? I thought you were sound asleep."

"What are you doing?"

"If you must know, having a snack."

"Having a snack? Madeline, I have the most insane feeling that your snack is the Feinbacher Galaxy."

"If we're going to be married, this is no time for coy secrets. Don't question your sanity, Herman. You're quite correct."

"Madeline. A star?"

"I know it seems awful to you. And I am sorry it has to be your Feinbacher. You're going to yell at me, and because of something some ancestor did light-years ago. My little nibble won't even show up for centuries."

"Your family has been nibbling at the Feinbacher for centuries?"

"Don't upset yourself. There are zillions of stars. You'll find another galaxy far off the menu."

"The menu?"

"Herman, the Avnolets are a very wealthy family, and we have been for rather a long while. Face it, we're not franks and beans. In fact, we gave up ordinary food when it got well, boring."

"Boring? So you learned to eat stars?"

"Yes, exactly. It's not very complicated, is it? In fact, it's quite logical, even predictable. We've eaten stars for as long as anyone close can remember, and we're not the only ones. What was I to do, Herman? Change our eating habits? And admit that stars do make a plentiful food supply."

"I admit that."

"And we're not talking about a cheap meal. Stars are for the taking. But when they just go... that requires some heavy explaining. The Avnolets have paid out a fortune to the best scientists to come up with a theory that took the focus off our silly little nibbling. Of course, they did. Novas, black holes, all sorts of charming ideas. The sad part for you is that the menu was planned far back. And each of us, in turn, promises to follow it. Once I took a star at random just because I was famished, and I never heard the end of it. I hate that the Feinbacher came up, especially at such an inopportune time. But even with two meals a day, the Feinbacher will last for millennia."

"Only two meals a day, Madeline?"

"I knew you would be upset."

"Upset. Yes, I am a bit upset."

"It's a small thing, really, Herman, once you learn the technique you'll adore the change. Stars are quite tasty. And no dishes to wash. No tables to clear. That means more time, and time is what you want. Time to work, time for us to be together, time for the children."

"Little star eaters. The whole bunch of us."

"They just slide down, darling. No cholesterol. Our family lives forever. Herman, instead of picking at the universe, now you can feast."

"Low calories?"

"That, too. The perfect food."

"And what about special occasions? Birthdays, Christmas, Thanksgiving?"

"Nebulae. Comets. There is some variety on the menu."

"Do I get my own spoon?"

"Daddy's amethyst."

Madeline came to Herman and held him. He held her as hard as he could. Love. Time. And what if the Feinbacher would vanish in a few thousand years, so long as there was an explanation? His children—bright, strong boys and wise, soft girls—would sit with their parents and suckle at the cosmos. Herman slid his hands up Madeline's body and stopped at her neck. His thumb could feel a wild pulse. He kissed her glittering mouth and could taste diamonds on her tongue. Then he tried to squeeze light out of her, but no light exploded from between her teeth. When she was dead he dragged her corpse to the surf and watched the tide float her out. There was some phosphorescence, but it faded quickly.

Madeline, who had swallowed stars, was now harvested by the sea. Herman felt a rush of sorrow, then strange peace. The night turned absolutely still. In the silence, Herman could hear time. Then an owl moaned and broke the crystal quiet.

Her blue spoon lay on the beach near a broken conch. Herman left the spoon but picked up the shell and traced its spirals. He wondered if such sea things had the urge to dream. Then he held the shell to his eye and peered through a crevice that broke its armor. He scanned the sky, looked past a moon webbed with clouds, to a nourishment of stars. ∞

This story is for Adam Jacobs on the occasion of his twenty-first birthday.

CREDITS

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BODY

CONTINUED FROM PAGE 22

(While digitalis is commonly used in the treatment of a variety of heart ailments, too much of the drug can cause dangerous arrhythmias even in healthy subjects.) "Digitalis can be used in the lab to create a predisposition to heart problems," Natelson explains.

After receiving the digitalis, all the animals were given the light signal. The group conditioned to receiving a shock after the signal responded as if to stress, although there was no outside stress. According to Natelson, those animals developed arrhythmias much more quickly than the group that was not conditioned. "We did another experiment on guinea pigs. In that one we administered the shock, but we didn't administer the digitalis," Natelson says. "None of the animals being studied developed arrhythmias."

Natelson believes stress is not life threatening for healthy people. "When you're under stress, your heart may race, but it probably won't threaten your ultimate health—whether you'll live or die," he says.

Eliot believes that you don't have to be predisposed to heart failure for mental stress to cause sudden death. Constant spurts of excess adrenaline provoked by stress can eventually produce cardiac disease, he contends. Dr. Thomas Graboys, a colleague of Lown's at Harvard, also believes that stress and the resulting surge of adrenaline may play a powerful role in triggering cardiac arrest in a seemingly healthy individual. Graboys points to the flood of chemicals called catecholamines (which include adrenaline) released by the nervous system during periods of extreme stress. These, he says, may rupture tiny cardiac muscle fibers, which in turn generate the electrical accidents thought to cause arrhythmias.

Other experts remain skeptical about the existence of any relationship between stress and sudden death. "It's been very difficult to nail down a firm link," says Dr. Anthony De Maria of the American College of Cardiology, citing the paucity of data available for evaluation.

Although the verdict on stress is not yet in, the available data indicate that it may play a more insidious role than previously believed. Eliot hopes to expand the National Center of Stress and Preventive Medicine into 20 regional centers and has already established a central facility in Denver. The centers will allow doctors to identify those at risk for sudden death.

"We have now developed elaborate and precise testing systems that measure physiological overreactions to mental stress," Eliot says. "These systems are capable of identifying those people we call hot reactors, or the one in every five healthy Americans who—when challenged with simple mental tasks—will react as if fighting saber-toothed tigers." ∞

EL CONDOR PASA

EARTH

By Cherri Senders

At first glance the proposal looks radical: introducing an exotic (foreign) species into an endangered species' habitat. But on closer inspection the plan is very tame. Working with a group of California biologists, Michael Wallace, curator of birds at the Los Angeles Zoo, plans to use the South American Andean condor to help save the Californian condor from extinction. The Andean birds will be used as surrogates to test the hazards of releasing the captive California birds into the wild. The team wants to release the Andean condors as early as next spring.

Ten to 15 same-sex Andean fledglings will be taken from U.S. zoos, radio-tagged, and released to gather data in the Los Padres National Forest, just northwest of Los Angeles. The chicks will be kept in pens until they are three to six months old, when they will be moved to the buttes or plateaus overlooking the canyons and chaparrals where the gentle scavengers will eventually roam.

At six to eight months they will teach themselves to fly, a process that takes about a month. In flight the huge scavengers, with wingspans up to nine and a half feet, forage more than 100 miles a day for food and tirelessly ride the hot thermal drafts in the canyons. Once they get the hang of maneuvering their huge bodies through the air, Wallace will teach the condors to forage for food by feeding them the same carrion they'd eat in the wild—dead coyotes, deer, bears, and cattle, and afterbirths—in their cages.

At this point the real work begins. The release team is particularly interested in using the Andean scavengers to find suitable release sites for their cousins—roosting cliffs that are safe from bears and coyotes and located high enough to take advantage of the canyons' thermal drafts. In addition, the surrogates will help scientists determine the best trapping techniques and allow them to test various wing-mounted radio transmitters. Most important, the scientists hope the Andean condors will tell them why so many California birds have died.

Only by radio-tagging the California condors in the wild have experts discovered that many birds died from lead poisoning after eating carcasses filled with buckshot. Other condors flew into power lines or died from agricultural poisons. "It pays to work out all the details so there aren't too many surprises when we release the captive California condors," says Wallace.

In the end, however, after all the money is spent (about $1 million a year is pumped into the condor program from all the various participating agencies) and all the work is completed, the survival of the species may boil down to a genetic crapshoot. Because more than half of the birds are siblings representing only three families, biologists agree that the condors are already in a genetic bottleneck. "In fact, we may be too late with the California condor," says Tom Hanscom, spokesman for the San Diego Wild Animal Park. "We may have inbreeding problems that won't show up for two or more generations. It just depends on the species and the complexities of the genetic code."

Genetic inbreeding could show up in physical defects or behavioral problems. The birds could suffer from reproductive-tract problems, malformed appendages, sterility, or thin eggshells. Behaviorally, the birds might not be able to feed themselves or breed with other condors.

Close encounters of the bird kind.

These magnificent vultures have soared above the California mountains since the Pleistocene, surviving even the mastodons. "Just because they didn't learn to nest on building ledges like pigeons or develop bulletproof vests doesn't mean they're evolutionary failures," says Lloyd Kiff, head of the condor-recovery team. "That they have survived despite human meddling is a testament to their strength."

But today only 27 California condors are left—all in captive-breeding programs at the Los Angeles Zoo and the San Diego Wild Animal Park. Because the species that reproduce the fastest tend to survive the best, the condor has several strikes against it. Condors breed slowly, laying a single egg every other year, somewhere between the ages of six and eight. "We're trying to build their numbers as rapidly as possible so that we can begin releasing them by the early Nineties," Wallace says. "There's no reason there couldn't be sixty to one hundred birds in the wild by the year 2000."

Not everyone is confident about the survival of the condors or of the Andean experiment. When exotic species are introduced into the habitats of native relatives, opponents contend, the newcomers often usurp the environment and upset the delicate balance of the whole ecosystem. "The scientists care only about the survival of the species," says environmentalist David Phillips, codirector of the Earth Islands Institute. "We care about the more global issues, like survival of the habitat."

According to Phillips, the Andean condor release program isn't going to tell scientists any more about what's going on in the wild than what they already know. "Whatever is bringing the California condor to the verge of extinction will be worse in five years," he says. "I would rather let the fight be won in the wild."

FORUM

CONTINUED FROM PAGE 18

Machine, and he wrote a brilliant riposte that hasn't dated a line in 80 years.

The story concerns a woman in a hexagonal cell, an intimate Media Room, in electronic communication with thousands of people. She's impatient when a tiresome son she hasn't seen since he was born interrupts her. He seems to have no interesting ideas to offer, just unseemly criticisms of the Machine that connects them and a demand that she come see him. She is very busy, she explains. She has a lecture to give in five minutes. Finally she visits her son, an arduous journey managed entirely by the Machine, and he tells her of a visit to the surface and his realization that only the Machine lives, that the people are dying. Disgusted by his heresy, she warns him he is doomed and returns in relief to her room. 'But there came a day when, without the slightest warning, without any previous hint of feebleness, the entire communication system broke down: all over the world, and the world as they understood it, ended.' As the world-size Machine destroys itself with all its humans, the son and mother meet a last time: the son gasping in triumph, 'I am dying—but we touch: we talk: not through the Machine.'

Everyone at the Media Lab would protest that Forster's Machine is exactly what they're seeking to prevent. Yet it is a Connection Machine right out of Danny Hillis's fantasies. (The Connection Machine is the most massively parallel of all parallel computers—76,536 processors operating at once. It is a brand-new machine introduced by Thinking Machines Corporation at $4 million. In July 1986 the Media Lab purchased the first one, initially at quarter strength with 16,384 processors. The Connection Machine was invented at MIT in the AI Lab by a Minsky protégé named Danny Hillis.)

Of course, that's what attracts us to a Media Lab. The lab flirts with dangers like living with addictive connectivity, total entertainment, and out-of-body experience. It inflates hubris and then mocks it. And through reinventing the media, it seeks to ensure that communication systems are human-based in their very texture.

The world Machine is coming anyway, with or without Negroponte's Media Lab at MIT. The earth is already wholly integrated. The coins in your pocket know about the price of oil, about apartheid in South Africa, about the Pope's opinions on birth control, about the Soviet space program, about dollar/yen exchange rates. All that will advance is the rate of knowing, the structure of new immediacies.

We can anticipate calamities of the emerging, accelerating world-information systems—sabotage, financial crashes, cultural pillagings, *faux* news stories, entertaining dictators. We must hope that such information disasters occur early and often, so that caution is built into us and into the systems.

While computers probe and imitate the "society of mind," they are also shaping the mind of society. Computers and communications have already blended so far that they are one activity, still without a verb to express what it does. We don't even have a word for the nervous activity in the body—it's not "thinking," "sensing," "talking." All chemical and energy activities in a body (or a society) have a word for their sum action—*metabolism*—but there's no equivalent word for the sum of communications in a system. The lack of a word signals a deeper ignorance. We don't know what constitutes healthy communication.

If humans are most distinguished from other organisms by the elaborateness of their communications, then the coming of new levels of world communications implies the arrival of something more than human. Cyborg civilization, maybe, or a cognitive planet.—Stewart Brand ∞

This excerpt was taken from Stewart Brand's book The Media Lab: Inventing the Future at MIT, *which will be published next month by Viking. Brand is founder and publisher of* The Whole Earth Catalog. *In 1985 he published* The Whole Earth Software Catalog.

STAR TECH

ACCESSING THE FUTURE

ELECTRIFIED BIRTH CONTROL

Within a few years a birth-control device may be on the market that electrocutes sperm. Gynecologist Steven Kaali recently patented a battery, designed to be placed in a woman's cervix or attached to a cap covering the cervix, that kills sperm by zapping them in a low-level electrical field.

The battery, which can be left in place for up to one year, produces only 500 microamps—less electricity than a pacemaker or an electric watch. "No one would feel anything from the current," Kaali insists, "except the sperm."

Since the battery is not placed in the uterus and because of its tiny size (equivalent to a quarter inch of a cotton swab), Kaali foresees few side effects. How well does electrical birth control work? So far, Kaali says, it has proved 100 percent effective in lab studies and very promising in animal experiments.

"Right now we're in the research-and-development stage," he notes. "When we will have the battery on the market is up to the FDA."—Sherry Baker

Access: The Kaali Birth Control Device may be available within two or three years—or possibly longer—depending on results from ongoing research and development. For further information, contact Steven Kaali, M.D., Medical Director, Women's Medical Pavilion, 38 Ashford Avenue, Dobbs Ferry, NY 10522.

CLASSES IN ZERO G

You hear a lot of talk about the commercialization of space these days. But what if the businesspeople who are *supposed* to be interested in space trade don't know anything about it?

That's exactly the problem that several new college-level business courses are trying to prevent. At Stanford University's Graduate School of Business, a class called "The Commercial Development of Space" was offered for the second year in a row this past April. The course, taught by logistics professor Gayton E. Germane, familiarizes students with such subjects as the physical quirks of space and the management of space enterprises and crises. It also covers up-and-coming areas of space business, like materials processing and communications satellites.

At California State University in Fresno, a course under development takes a slightly different approach. According to Joseph Penbera, dean of the school of business, the course will be geared more toward space *marketing*. "We're trying to develop the appropriate linkage between NASA's mission and what business people need," he says.

Both courses were initiated with the help of NASA's Ames Research Center. "If we're going to do this commercialization thing, we have to get business-oriented people thinking about space," says Larry Milov, manager of commercial programs at Ames. The best time to do this, he adds, is while tomorrow's businesspeople are still in school.—Devera Pine

Access: Graduate School of Business, Stanford University, Stanford, CA 94305. School of Business and Administrative Sciences, California State University at Fresno, Fresno, CA 93740.

DEAR BARNY

The computer has come to the aid of teenagers too shy (or wary) to ask their parents about the birds and the bees. In fact, the new *BARN* (Body Awareness Resources Network) program can also answer kids' questions about drugs, diet, smoking, or stress—all in complete confidence.

BARN's 25-hour, 37-disk program was developed by the University of Wisconsin's Center for Health Systems Research and Analysis and targeted for junior high and high schools. Kids can go directly to the computer, plug in the appropriate disk, type in their question, then watch as *BARN* provides information that will help them answer it. To hold kids' interest, the language is colloquial, and the formats are upbeat. There's a space-adventure video game that calls on users to choose the right foods to meet the challenges of a spaceflight, and an Ann Landers-style "Dear BARNY" that answers touchy questions about sex.

—Bill Lawren

Access: The $1,195 program is available from *Encyclopaedia Britannica*, 425 North Michigan Avenue, Chicago, IL 60611.

STAR TECH

THE TESLAR WATCH

It looks like any number of multifunctional digital watches, but the Teslar has an added feature. It protects the wearer from harmful electromagnetic fields, or so claims the inventor. Invented by physician/scientist/researcher Andrija Puharich, who is probably best known for introducing psychics Uri Geller and Peter Hurkos to the world, the Teslar shields against the unhealthy effects of extremely low frequencies known as ELF waves.

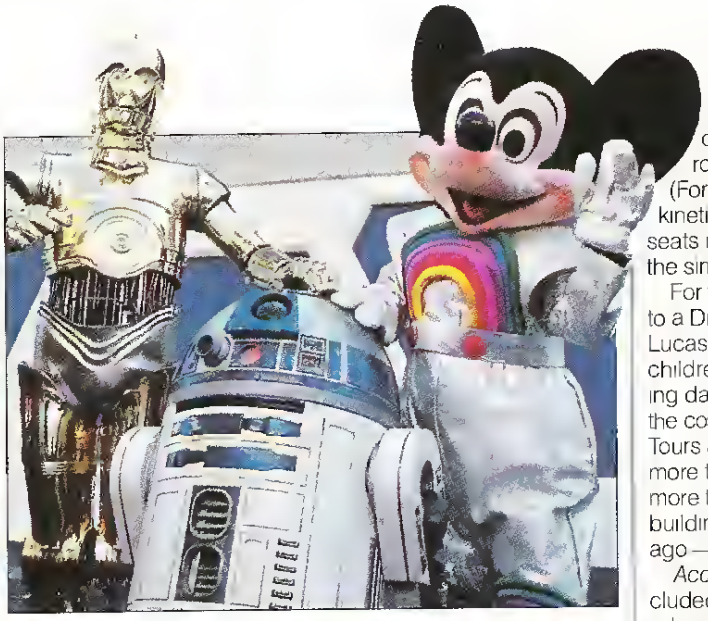
According to Puharich, ELF waves—electromagnetic fields ranging from 1 to 41 hertz—can affect biological systems for better or worse in spite of their ultraweak

power. Research has shown that ELF waves pass through any material and interact with DNA molecules.

"What's more, our society is saturated with ELF. Video display terminals, television sets, and such other electronic equipment constantly generate signals that are destructive," says Puharich.

Named for electrical genius Nikola Tesla, whose discoveries led to the technology used to produce it, the $79 Teslar features a magnetic wafer that attracts and traps destructive ELF waves. These frequencies, according to Puharich, are then converted to an eight-hertz signal, aligning the magnetic system of the body so that it resonates at its natural frequency.—A.J.S. Rayl

Access: E.L.F. Cocoon Corporation, Route 1, Box 545, Dobson, NC 27017



LUCASLAND

It's billed as the "ultimate attraction" at Disneyland in Anaheim, California. But Star Tours, created by George Lucas and Disney's "imagineers," is really a show-biz version of the flight simulator technology employed by airlines and the government to train pilots.

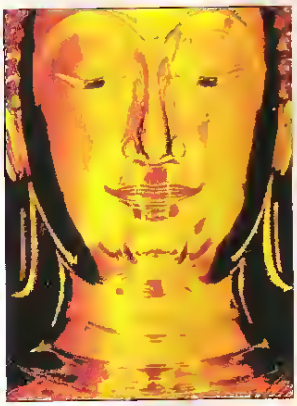
Based on the familiar scenes and characters from Lucas's *Star Wars* film trilogy, Star Tours passengers board one of four Starspeeders for a leisurely voyage to the fictitious moon of Endor. Instead, though, their rookie android pilot takes them on an intergalactic steeplechase through a storm of comets, a battle with a fleet of enemy space fighters, and, finally, into an obstacle course in the canyons of Darth Vader's *Death Star*.

Each Starspeeder is really a 40-passenger movie theater built atop a hydraulically controlled motion-simulator platform from Europe's Rediffusion, the same company that builds jet trainers. The "view" out of the ship's front window is the longest continuous single sequence ever attempted by Industrial Light and Magic, Lucas's special-effects shop. The perfect synchronization of the movements of the simulator with the on-screen action yields an uncanny sense of realism—practically as good as the experience of riding a top-notch roller coaster. (For the best and most kinetic effect, try the corner seats in the back row of the simulator.)

For the record, according to a Disneyland spokesman, Lucas was among the first children in the park on opening day, July 17, 1955. And the cost of the Lucas Star Tours attraction—reportedly more than $30 million—is more than the entire cost of building Disneyland 32 years ago.—Timothy Onosko

Access: Star Tours is included in the one-price admission to Disneyland: $19.50 for adults, $14.50 for children.

HIGH-TECH SYNCHRONICITY



Brother Charles, a nonsectarian monk, has opened an elaborate multisensory environment in rural Virginia designed to "accelerate the evolution of human consciousness."

Among the free experiences offered on the 400-acre estate is "synchronicity."

Picture this: You enter a gaily painted, 12-sided structure decked with crystals "to amplify the frequencies." You recline on a chaise longue with a built-in headset and stereo speakers, while mandala images shift slowly along the walls and perfumes waft through the air.

Then you don headphones. Musical or environmental tracks, like the sound of ocean waves, hide a patented technique of sound phasing called holodynamics, which Brother Charles likens to the use of mantras, or repetitive incantations, to quiet the brain. Relaxed now, you're ready to receive subliminal messages—for example, "I am all that is"—that are supposed to bring on feelings of peace.

"The technologies," says Brother Charles, "can deliver the experience to people without a lot of talk."

—Connie Zweig

Access: Contact MSH Associates, Route 1, Box 192-B, Faber, VA 22938.

TALKING MACHINE

While voice synthesizers have been available for some years, their high cost and complexity have placed them beyond the reach of most people with severe speaking disabilities.

So Bob Russell, a psychiatric technician and director of communication engineering at California's Sonoma Developmental Center, invented SonomaVoice (above), a portable synthesizer that generates human speech in sentences at the touch of a button.

The standard SonomaVoice costs $340 and has a matrix of 16 keys that can produce 64 phrases. A shift-key option expands the phrase output to 256. The matrix features inch-and-a-half circular keys designated by removable graphics that represent the phrase that will be spoken when the key is pressed, with a different set of graphics for each level.

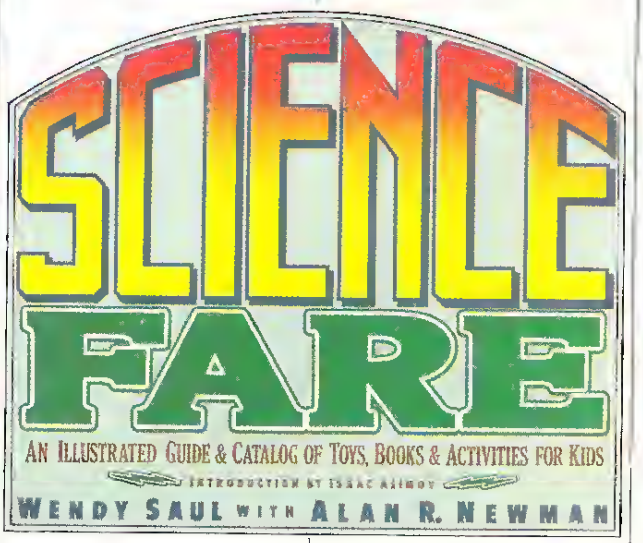
About the size of a portable typewriter, each SonomaVoice weighs just under five pounds, runs all day on a battery charge, and can be held on the user's lap or mounted on a wheelchair.—A.J.S. Rayl

Access: Bob Russell, Communication Engineering, Sonoma Developmental Center, Eldridge, CA 95431. Phone: (707) 938-6306.

RAISING MARIE CURIE

What if your daughter begs to dissect the neighbor's cat? What if little Johnny wants to play with carbon tetrachloride? Or what if you haven't a clue how to make a terrarium, don't know what a phylum is, and wouldn't know Orion from Ryan O'Neal?

Science Fare, by the wife-and-husband team of Wendy Saul (a teacher) and Alan R. Newman (a chemist), calls itself "an illustrated guide and catalogue of toys, books, and activities for kids," but it is more than that. It also tells you how to be Marie Curie's mom or dad. For example, you'll learn where to find the answer when your eight-year-old asks impossible questions about the Crab Nebula, how to teach your two-year-old the rudiments of classification and observation, or how to find the right science project for a handicapped child. There are tips on coping with messes, dangerous rocket kits, hamsters, and science fairs. And, of course, there's a comprehensive listing of science books, clubs, camps, and catalogs, as well as chemistry sets, fossil-gathering tools, electronics suppliers, and just about everything else under the sun.—Judith Hooper



Access: *Science Fare* is published by Harper & Row. Price: $14.95.

J&B PRESENTS THE TELEPHONE CRYPT III

Code. The very word is intriguing. It conjures up mystery, concealment. It speaks in a language known only to the sender and to those rare individuals privy to the secret.

To make the meaning perfectly clear, the translation unambiguous, usually each letter is represented by one specific symbol in decoding. The 26 letters in the alphabet translate to 26 different letters in the code. But it is possible to use far fewer symbols in the code and still get the meaning across in context.

In the following code, the message was spelled out on a telephone dial, with each number standing for one of three letters:

2 = ABC
3 = DEF
4 = GHI
5 = JKL
6 = MNO
7 = PRS
8 = TUV
9 = WXY

For our purposes we'll use the numeral "1" to indicate punctuation marks and "0" for spaces between words. Now, the message has some built-in ambiguity. The number "8" could stand for a *T*, a *U*, or a *V*. The "4" could be a *G*, an *H*, or an *I*.

Does that ambiguity make the message indecipherable? Not at all. Because of the regularity (predictability) of English in context, there is only one solution.

Look for the solution to the following puzzle next month in *Omni*.

15483706304732806360

2550736463087093022 60

625306870548370

78254631026310

33727846410532830

2344630870366877468 70

6608430726370630

84631101436790

923796784056643355690

437317086072730

2427228371

BODY DOUBLES

CONTINUED FROM PAGE 50

the task is different. Here living cells must be recruited to assist in the manufacturing process. Scientists first snip a little RNA (a specific type of nucleic acid) from a sample of the protein they want to mass-produce, then, using this as a sort of cellular instruction manual, they assemble the appropriate enzymes to synthesize a single gene from that protein. The new gene is inserted into the nucleus of a living bacterium, usually the simple *E. coli*, in part because it is easy to grow and too fragile to live outside the lab should some bacteria escape. From this point on, the process is automatic.

"The bacterium is stupid," explains Stanford endocrinologist Ron Rosenfeld, one of the major pioneers in protein research. "It accepts the new gene as its own. When the gene instructs the *E. coli* to start creating the protein, the *E. coli* complies. In effect, the bacteria become a little factory for whatever we want to make." The *E. coli* are then stored in vats, where they obediently and endlessly churn out whatever they've been told. Later the vats are opened, the bacteria are killed, and the protein is purified.

It was this technique, known as recombinant DNA, that first inspired a new group of researchers to study proteins. Sadee himself, trained at institutes in Zurich and Berlin, came to the United States in 1971 intending to study drug chemistry and metabolism. But the potential of protein research was too seductive. "I realized that protein manipulation might one day be an accomplishment every bit as significant as the discovery of DNA," he says in his UCSF office. "Once the structure of these substances is completely understood, medicine will have succeeded in cracking the second genetic code."

OPIATE BOOSTERS

So promising is the field that Sadee is having trouble deciding where to focus his attention. At the moment he's concentrating on creating new types of pain relievers and anesthetics. Though the body produces its own opiates, Western scientists have rarely paid much attention to them. Instead they have relied on synthetic anesthetics that work on the body like a chemical clubbing, easing pain not by relaxing the central nervous system but by doping and dosing it. Sadee believes the natural opiates can do a better job and with fewer side effects.

"The first step," he explains, "is to study natural opiates like endorphins to understand how they work. Then we can try to mimic them synthetically."

If all goes well, researchers will one day be able to change the amino acid sequence of a particular endorphin or other opiate to tailor it to perform a specific task or to serve the needs of specific patients.

Such mutated molecules are known as muteins. Short, manually built muteins are easy enough to assemble. Simply change the order of the amino acids when they're being chemically strung together and the resulting protein will perform differently. But longer, more complicated recombinantly built muteins are a bit trickier, requiring scientists to craft an entirely new gene that, when inserted into the *E. coli* nucleus, will instruct it to produce an entirely new protein. Tough as this process may be, Sadee believes the medical benefits will be worth the scientists' sweat. "Every place we look in the body," he says, "another healing protein appears." Researchers have found a protein called relaxin that seems, appropriately enough, to relax the uterus during childbirth. There are others that work as growth factors to help bones heal. Another, called erythropoietin, affects bone marrow stem cells and could be used to treat anemia. "There's no limit to these substances," Sadee says, "and the faster we learn to use them, the more people we'll be able to help."

"Within a decade nearly half of all therapies and drug treatments could be replaced by the results of the protein tinkering taking place in labs today."

THE VERSATILE MONOCLONAL

Cell biologist Frances Brodsky wasn't wooed into the study of proteins as Sadee was. She is a first-generation researcher whose work with monoclonal antibodies has spurred her confidence in the importance of protein manipulation.

Antibodies are immune-system killer cells that prowl the human body looking for disease, including malignancies, flushing out affected cells and annihilating them on the spot. These search-and-destroy proteins are produced naturally in the spleen and every day protect the body from disease. But often antibodies are too inefficient to destroy fast-growing cancer cells, and disease takes hold.

At the beginning of the decade investigators began to develop procedures to enhance antibodies' effectiveness. The idea was to use outside help in the form of artificially produced antibodies. "We take a single spleen cell and immortalize it, cloning it and growing it outside the body," explains Brodsky. Then researchers arm the antibodies with a toxic chemical that is deadly to cancer cells. Once the altered cells, called monoclonal antibodies, are introduced into the body, they need no assistance from the immune system to kill the cancer cells. "This magic-bullet approach to cancer therapy is still in the experimental stage," says Brodsky, "but initial results look promising."

But monoclonals could do more than treat cancer. Indeed, Brodsky sees practically no limit to their versatility. "Monoclonals are vehicles that could carry material to any part of the body," she says. "It's possible that you could use them to carry genetic material into a cell and reverse genetic defects."

In Brodsky's and others' scientific scenarios, a patient with a congenital disease like, say, diabetes wouldn't simply be treated for the illness but would be genetically retooled with new, healthy DNA coding for proper processing of sugar. "We're learning to mimic viruses," she says, "which do their work in exactly the same way, entering cells and bringing their own genetic material along."

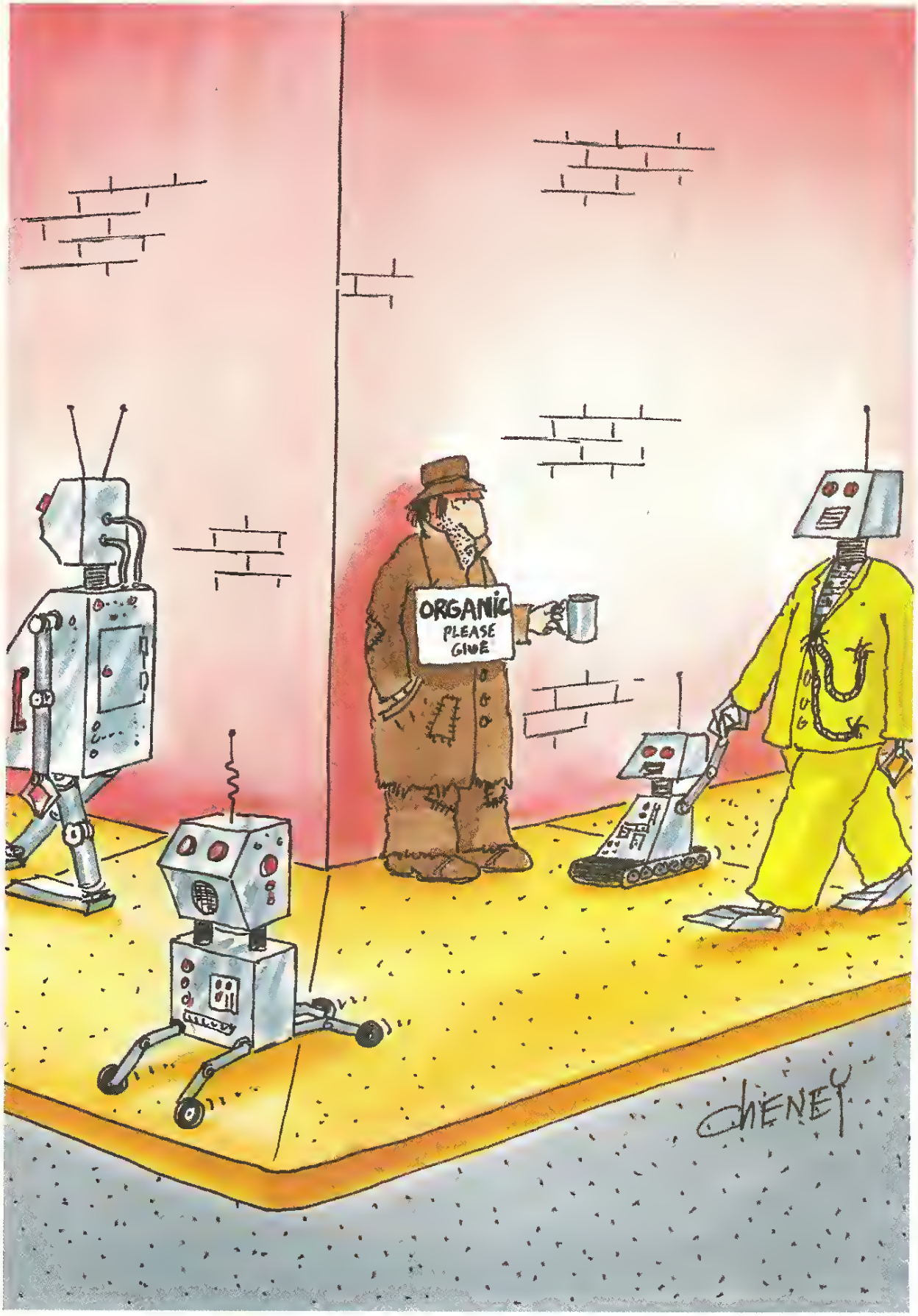
At the Biological Therapy Institute in Franklin, Tennessee, still another spin has been put on monoclonal technology. There resident doctors tailor antibodies for each patient. Rather than just building a single monoclonal missile to carry the same genetic payload in all patients, the scientists are developing antibodies that are slightly different for every recipient.

"The first thing we do," explains institute oncologist Robert Oldham, "is take a biopsy of the tumor and look to see if we have antibodies already on the shelf that will stick to it. If we do, we make up a cocktail of those antibodies and treat the patient with it. If we don't, we start making up new antibodies, trying to find the ones that will work best on that patient's malignant cells."

Oldham's program is expensive. Patients pay $35,000. And the institute offers no guarantees. "The fee is for our research," Oldham says. "It's a 'best effort' kind of thing. The patients are not purchasing a product."

But guaranteed expense and unguaranteed results aren't the only drawbacks to Oldham's program. Of even greater concern is the effect that such personalized treatments could have on the development of more mainstream cancer therapies. Where, many ask, will science get research volunteers when more and more cancer patients are disappearing into private institutes hoping—and paying—for their own custom-made cures?

"That's a bugaboo ethical question," answers institute president Louis Berneman. "Historically, dramatic breakthroughs in managing diseases are not seen through experiments and control groups but through actual long-term treatment programs like ours. Besides, no patients are accepted into the institute's program unless they have already failed or are likely to fail standard therapies."


ORGANIC
PLEASE
GIVE
CHENEY

AIDS

The hunt for a recombinant vaccine to immunize people against the AIDS virus has spawned some of the most important protein work. At American drug companies like Genentech, Cetus, and Chiron, scientists are exploring an approach in which a protein mimicking the cell wall of the AIDS virus could be synthesized recombinantly and then injected into the bloodstream. Essentially a viral skin without the guts, the cellular shell would represent just enough of the virus to cause the immune system to produce antibodies against the disease but *not* enough to cause actual sickness. "All vaccines work essentially this way," explains Rosenfeld.

Elsewhere, other, even more imaginative techniques are being tried. At the Pierre and Marie Curie Institute in Paris, researcher Daniel Zagury is experimenting with a sort of piggyback vaccine in which bits of the AIDS virus are inserted into smallpox vaccine and then introduced into the body. Since the smallpox virus is alive—though stripped of its disease-causing properties—it behaves far more aggressively than a simple cell wall. Rather than passively drifting through the bloodstream, it actively invades the body's cells. The smallpox vaccine could thus serve as a cellular vehicle to deliver the AIDS vaccine quickly and more efficiently. Zagury has already inoculated a dozen volunteers and—significantly—himself with the hybrid vaccine. Preliminary blood studies indicate that the experimental cells do indeed cause the immune system to produce antibodies to the AIDS virus.

The next step will be to discover whether these antibodies actually protect against the disease. But that, of course, is a knotty business. In order to verify his theories, Zagury and his group of volunteers will have to expose themselves to the AIDS virus, a step they have been understandably reluctant to take. For this reason, all the volunteers are from Zaire, a country where AIDS is raging through the population almost unchecked. The grim reality of infection rates indicates that when Zagury's subjects return home, at least one of them is likely to come in contact with the virus naturally. Only when this happens can the effectiveness of the vaccine be determined.

INTERLEUKIN-2

Dick Howser had a headache. And it wasn't a night he could *afford* a headache. In a few minutes ABC Television would switch on its cameras, and a worldwide audience would settle back to watch baseball's 1986 All-Star game. As manager of the Kansas City Royals, the World Series champions, Howser was given the honor of leading the American League team that night. It was another plum, another perk in what had been a year of triumph. It should have been a night to treasure. But he had this headache.

Actually, Howser had been hurting for days, and he was beginning to worry. After the game—which his American Leaguers won three to two—he finally agreed to fly home for a checkup.

Howser's doctor didn't like what he heard: the persistent pulse of the pain, its location, its duration. Worse, the patient seemed confused, disoriented, fuzzy. The doctor asked Howser some routine questions. Did he recognize the baseball executive—and close friend—standing next to him? Well, no. Did his team win or lose yesterday? Uh, they won. What was the score? The All-Star manager had no idea.

Tests revealed that Howser had a glioblastoma, a vicious form of malignant brain tumor striking only half a dozen out of every 100,000 people. He would immediately undergo surgery and begin therapy. Even so, there was a very good chance he could die within a few months.

But for close to a year, Dick Howser managed to hold the disease at bay. Howser's doctor, Skip Jacques of the Huntington Medical Research Institutes in Pasadena, California, refused to claim a cure or even predict a lengthy remission. He boasted of only one thing: For a time, Dick Howser beat the odds, and he beat them courtesy of interleukin-2.

> *"I hate to sound like a homeopath, but one day we may even see people taking preventive doses of interleukin-2 just to keep their immune systems up."*

Hundreds of amino acids long, interleukin-2 is made naturally by the lymph glands and is responsible for helping T cells—major components of the immune system—grow and divide. The more numerous and aggressive T cells are, the better chance they have of combating bodily invaders, including cancers. Scientists have long known that if interleukin-2 could be harnessed therapeutically, it could go a long way in battling malignancies.

The technique Jacques and other doctors use is relatively simple. A few of a patient's T cells are withdrawn from the body, isolated in dishes, and mixed with interleukin-2 that has been derived from animals or manufactured recombinantly.

"Mixing interleukin-2 with T cells is a little like giving a mean drunk a drink," Jacques says. "It makes them much fiercer." And much more numerous. When the doctors return and open their dishes, they've got a teeming population of excited T cells. Reintroduced into the patient's body, the cells hunt down a malignancy and attack it. Indeed, like bloodhounds, they may sometimes be exposed to the scent of their quarry before the chase begins. While the T cells are still being grown in the lab, doctors often drop in a few of the patient's cancer cells to sensitize the hunters to the prey.

Interleukin-2 is now being used experimentally to treat all manner of cancers, from body-wide systemic diseases like leukemia to localized tumors like Howser's. As similar as the chemistry of the different treatments is, the mechanics vary. Leukemia can be treated with a simple interleukin-2 injection, cancers like Howser's demand a more complicated treatment. The patient's harvested T cells are mixed into a plasma goo made up of calcium, nutrients, and a little extra interleukin-2—"to keep the cells nice and vicious," Jacques says. Rolled into a ball to approximate the size of the now-absent tumor, the plasma is inserted into the hole left in the brain. "A brain tumor is a little like a tennis ball in a bowl of Jell-O," says Jacques. "You can take the ball out, but you can't be sure how much fuzz was left behind. And it's the fuzz we're going after."

Some patients may need just one treatment, others, several. Howser received two in his last nine months. Even the most optimistic study shows that interleukin-2 was effective in just 31 percent of malignancies. In the case of diseases like Howser's, however, in which survival rates are less than 2 percent, interleukin-2's success rate looks good.

Good enough, in fact, to get people like Jacques thinking about the future. "I hate to sound like a homeopath," he says, "but this treatment is a natural treatment. One day we may even see people taking preventive doses of interleukin-2 just to keep their immune systems up. This could lead practically anywhere."

But interleukin-2 has some serious side effects, including liver damage, fluid retention, kidney damage, and psychological problems such as hallucinations and severe mood disturbances. One of the goals of protein research is to develop methods for removing the side-effect-producing elements in interleukin-2 while retaining its therapeutic properties.

Despite the considerable problems to be overcome, Jacques is convinced that immunotherapies like monoclonal antibodies and interleukin-2 represent the future of cancer care. "The new treatments have gotten us off the constant merry-go-round of chemotherapy," he explains. "Chemo gets the cancer cell count down, but too often, it doesn't get that last cell. In theory, the immune system should be able to do that. We're just helping it along."

HUMAN GROWTH HORMONE

More than a decade ago, as an intern in pediatric endocrinology, Ron Rosenfeld first met an eleven-year-old patient named

Dennis Palmer (not his real name). Dennis was suffering from a serious case of childhood growth deficiency and had been brought to Rosenfeld for treatment. For the next 11 years Rosenfeld met with his patient almost weekly, administering carefully controlled doses of a newly discovered protein known as human growth hormone (hGH). Extracted from the pituitary glands of human cadavers, hGH was expensive and in limited supply, but in patients like Dennis, it seemed to do the trick. Over the course of 11 years the boy grew steadily taller until, by age twenty-two, he had finally moved into the range of normal height for his age.

But in 1984 Dennis began having trouble. When he showed up for one of his weekly treatments, Rosenfeld noticed that his gait had become awkward, his step wobbly. Within a few weeks his speech became labored and slurred. Over time dementia set in. Stripped of motor and speech skills, the patient lost all touch with his surroundings. By 1985 Dennis Palmer was dead, a victim of an extraordinarily rare illness known as Creutzfeldt-Jakob disease.

What worried Rosenfeld most was that Creutzfeldt-Jakob bore a striking resemblance to an obscure disease known as kuru, which appears almost exclusively among primitive New Guinea tribesmen. Western doctors who had treated kuru victims suspected that the disease was caused by a tribal funeral custom in which portions of the brain of the deceased were eaten by mourners, when the brain tissue was ingested, so was a naturally occurring, disease-causing chemical known as prion. Was it possible that prion was also present in brain-derived hGH? The answer turned out to be yes. Within a few months three other patients receiving the growth hormone had died of Creutzfeldt-Jakob. The Food and Drug Administration (FDA) pulled hGH from the shelves, a move that left thousands of growth-hormone-deficient children without any treatment at all. The only alternative was to develop a safe synthetic form of hGH. Genentech Incorporated, a bioengineering firm in California, had been working on a synthetic hGH substitute for several years. "But by 1985," explains Rosenfeld, who had been casually involved with Genentech's work, "it became obvious that the work had to be completed fast and that the FDA had to grant its approval of the stuff."

In the fall of that year the FDA did just that, licensing prion-free hGH for therapeutic use. For Rosenfeld the moment was more than a breakthrough. "The kind of patient we see most often in pediatric endocrinology is the child with growth deficiency," he says. "What were we supposed to do in 1985? Stop treating them? With recombinant technology we suddenly had the capability to synthesize unlimited amounts of safe hGH and to do so faster and cheaper. At the moment, about twenty thousand people worldwide are receiving the medication."

To be sure, even lab-created hGH is pricey. The hormone sells for up to $35 per milligram, a year's treatment can run between $5,000 and $25,000, and some children must be on medication for 5, 10, or even 15 years. Rosenfeld concedes that this raises some ethical questions. "Who should pay for the treatment? Will we get into a situation where only the affluent will be allowed to grow? Worse, for those who *can* afford hGH, the question arises as to how short is too short? Will parents start giving the hormone to normal-size children in order to make them taller?"

Despite such concerns, Rosenfeld remains one of the more vocal partisans of protein tinkering. Like Sadee, he is old enough to remember the time before science knew what to do with proteins, and, like Sadee, he sees the field's potential. "Basically, the apparatus is now in place to synthesize any protein at all. What's more, we're not limited simply to copying the proteins that already exist in nature. If we wanted, we could make a super growth hormone. We could learn to make cancer-fighting proteins like interferon or a substance known as tumor necrosis factor, which shrinks malignant growths. We could manufacture vaccines against all manner of illnesses: meningitis, encephalitis, influenza, and malaria."

The field is wide open. At the Syntex Drug Company in Palo Alto, California, scientists are working on a recombinant synthesis of a hormone known as inhibin, which is capable of adjusting the fertility functions of the pituitary gland and providing safe birth control in both males and females. In other labs, studies are taking place that could synthesize vaccines for Epstein-Barr virus and foot-and-mouth disease. Elsewhere, protein researchers are working on recombinant cures for malaria.

Indeed, even the soberest scientists agree that there is nothing that the new research couldn't someday treat or cure. We don't just contain protein, the thinking goes; we *are* protein. And once you know how to handle the clay, you can make the sculpture come out any way you want.

Of course, such power carries its share of responsibilities—both ethical and scientific. Some skeptics worry that in the process of developing a new vaccine, scientists may accidentally create a new virus. It's certainly possible, and protein researchers are well aware of the dangers. Nevertheless, these scientists are also aware of the other side of the moral coin. If they can learn to make proteins that will cure or prevent a disease, isn't there an obligation to do so?

For Wolfgang Sadee and the other architects of protein structure, the answer is a resounding yes. They also have the pleasure of working in a field where there's no need to exaggerate the possibilities. "It is the responsibility of scientists not to generate optimism and hope where there is none," says Sadee. "But in the case of proteins, there is much of both."

INTERVIEW

CONTINUED FROM PAGE 66

cent is $1,083.56, compounded at 27 percent, it's $39,364.72.—*Editor*]

Omni: Is there a future to using math to predict fluctuations in stock prices?

Shannon: I think it is easier to predict which of the companies are going to succeed than to predict short-term fluctuations, things lasting only weeks or months, which they worry about on *Wall Street Week*. There is a lot more randomness in that unpredictable things happen that cause selling or buying pressure. If you get into the short-term thing, you keep paying short-term capital gains. With a long term thing, you may never pay taxes because you keep it forever.

Omni: Given your fondness for gadgets, it seems odd that you don't relish playing with computers.

Shannon: Feeding programs into a computer is kind of dull. Designing computers is more to my taste, but I haven't felt much like it lately. I guess I've had a bellyful of that general game. I do like the physical aspects of these things, but mathematics itself involves symbolics. I've often worked on problems and theorems that never had a physical object.

Omni: Did you make the motorized pogo stick hanging in your garage?

Shannon: I bought it from a guy in New Jersey, who made it. It's gasoline driven and has a piston that fires each time it comes down. You go along at great velocity. Ha-ha. But I found it very uncomfortable. It was quite a shock each time the piston exploded.

Omni: What became of your project to use a computer and radio to win at roulette in Las Vegas?

Shannon: The thing worked very well here in the house. The roulette wheel—a real professional one—is up in the attic now. The predictor would indicate which half of the wheel the ball was going to fall into. It had a much better than fifty–fifty prognosis. Two thirds of the time it would predict the right half of the wheel, so you would win at a very good rate if you kept playing.

This partly depends on the fact that wheels in Las Vegas and elsewhere are tilted. We examined many wheels and could see some of them were tilted quite strongly. If you play any of these, there's a strong probability that the ball will fall out in a certain segment of the outside of the wheel. And you can tell quite well how long it will take for that to happen. The wheel is going around one way, and the ball is going around the other, so by timing the spinning of the wheel, you can determine where it's going to be when the ball falls in. It's a very simple dynamic system with little friction.

Omni: Wouldn't you have to consider the strength of the croupier's throw?

Shannon: Our device timed both the wheel and the ball. The person standing there would press a button when the wheel was spun and the double zero went by a certain point and again when the ball was thrown, passed a certain point, and came around again to that point. So even if the croupier threw the ball at different speeds, that was calculated into the prediction. Both the speed of the wheel and the moment the ball left the croupier's hand were evaluated by our little computer. But we had a lot of practical problems, and we never really made any money. Had we been willing to spend another month cleaning up details, we probably would have won.

Omni: You once wrote that the redundancy of a language determined whether it could have crossword puzzles; and since English has a redundancy of about half, it couldn't be used for three-dimensional puzzles. Right?

Shannon: Yes. You can't build big ones in three dimensions. There are so many constraints among the letters of a single given word that tie it together. In English it gets even harder to find other words that will tie it together in a two-dimensional pattern. A fortiori, if I may use another English word—ha-ha—it gets even harder to tie them together in three dimensions.

Omni: If you were funded, could you build a robot that rides a bicycle?

Shannon: Oh, I have already built little bicycle riders. I have one four inches high that rides a tiny two-wheeled cycle. That's almost trivial. I worked on a little mechanical unicycle but never got that working.

Omni: Is it true you investigated the idea of mirrored rooms?

Shannon: Yes. I tried to work out all the possible mirrored rooms that made sense, such that if you looked everywhere from inside one, space would be divided into a bunch of rooms, and you would be in each room, and this would go on to infinity without contradiction. That is, you'd move your head around, and everything would look sensible. I think there were seven rooms. I planned to build them all in my extra room here and give people an exciting tour. The simplest case would be a cube where you would just see an infinite series of yourself receding into the distance. All of space would be divided sensibly into these cubical patterns. But other ones, like tetrahedra [four-sided solids] and so on, yield much more complex and interesting patterns. I will build them if I can finish all my other projects!

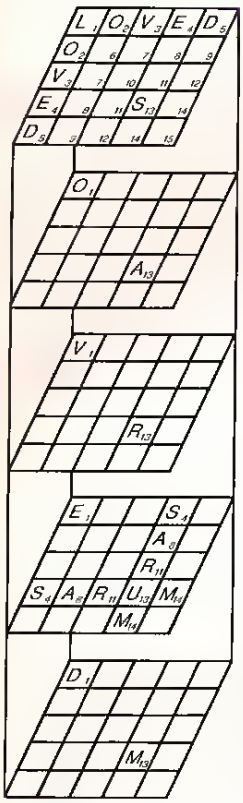
At the moment I'm working on another juggling machine, which might juggle five balls. I'm using an air hockey table [a game in which pucks travel on cushions of air] and plan to juggle discs by tilting the table.

Omni: What would you say is your secret in remaining so carefree?

Shannon: I do what comes naturally, and usefulness is not my main goal. I like to solve new problems all the time. I keep asking myself: *How would you do this? Is it possible to make a machine to do that? Can you prove this theorem?* These are my kinds of problems. Not because I'm going to do something useful.

GAMES

CONTINUED FROM PAGE 113



L	O	V	E	D
O	P	E	R	A
V	E	L	A	R
E	R	A	S	E
D	A	R	E	S

O	P	E	R	A
P	U	R	E	R
E	R	O	D	E
R	E	D	A	N
A	R	E	N	A

V	E	L	A	R
E	R	O	D	E
L	O	G	O	S
A	D	O	R	E
R	E	S	E	T

E	R	A	S	E
R	E	D	A	N
A	D	O	R	E
S	A	R	U	M
E	N	E	M	Y

D	A	R	E	S
A	R	E	N	A
R	E	S	E	T
E	N	E	M	Y
S	A	T	Y	R

QUIZ ANSWERS

1. The word for the twenty-third letter of the alphabet—*W*.

2. The fifth number is (b) 24,689. The numbers represent "poker hands" in ascending value: 1) one pair, 2) two pair, 3) three of a kind, 4) straight, 5) flush, 6) full house, 7) four of a kind. For term five—a flush—all the digits must be different.

3. Three of the same digits will appear 24 times: 1:11, 2:22, 3:33, 4:44, 5:55, 10:00, 10:11, 11:01, 11:10, 11:11 through 11:19, 11:21, 11:31, 11:41, 11:51, 12:11, and 12:22.

4. There are three possible combinations: seven dimes and six nickels, one quarter, three dimes, and nine nickels, or two quarters, three dimes, three nickels, and five pennies.

5. Because there are only two railway stations in Boston, North Station can't be the *largest*, it's the larger.

6. The common traits: 1) straight lines, 2) letters on a phone dial, 3) vertical symmetry—the left and right of each letter are mirror images of each other, 4) each letter has an exact counterpart in the Greek alphabet in terms of how it is formed, 5) horizontal symmetry—the top and bottom of each letter are mirror images of each other, 6) Roman numerals, 7 and 8) letters enclose an open area, 9) each *can* be drawn without retracing or lifting pen from paper, 10) lowercase descenders—gjpqy, 11) the middle row of letters on a typewriter.

Compliments of our readers: words and numbers to rack your brains

GAMES

By Scot Morris

Periodically readers send us original quizzes, puzzles, and other trivial pursuits that are sometimes not only clever but also quite remarkable. This month we feature two such ideas submitted by Peter Graham of Papakura, New Zealand.

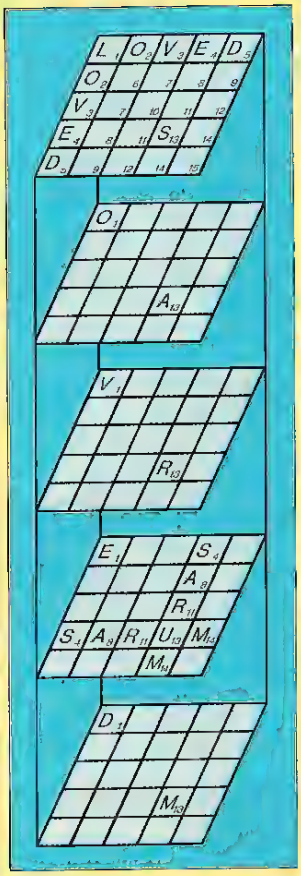
In Graham's version of the word cube (right), there are five-letter words running across and down each square. Each word can be found by reading down through one cell of each square. For example, each letter of the word *loved* appears across and down square one, as well as in the first cell of each square, each letter of the word *Sarum*, likewise, appears in square four and in cell 13 of each square.

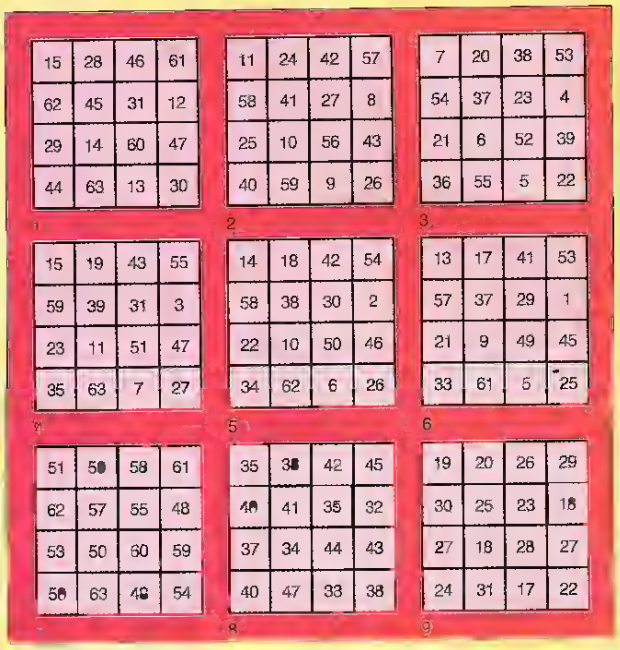
Having worked out his word-square puzzle, Graham set the clues in verse (below). Each line of the poem is a clue to each of the 15 words. All the words appear in the fourth edition of the *Concise Oxford Dictionary*, and remarkably, most of them are common.

In the first line, the clue is *desired with passion*, the answer, *loved*, is shown in cell number one of each square. The answer to number 13 is *Sarum*, related to a rite that originated near *Salisbury*, England, its letters appear in cell 13 of each square. It's now up to you to determine the other thirteen words.

1. *Desired with passion*, yet too fond
2. of *drama's music*, our adieu
3. produces a *soft palate* sound
4. *Delete* the dreams that we once knew
5. love *challenges* that breakup, too
6. *More innocent* or maybe blind,
7. we doubted time would *wear away*
8. the *shielding* walls our love aligned,
9. but now *where combat seems like play*,
10. the *words* that save are hard to say
11. Yet still I *worship* you or would
12. if we could *set* love *right once more*,
13. but far from *Salisbury* past good
14. flowed to an end. The *opponent* swore
15. *horns and hooses* danced at each door.

Answers are on page 111





THE MAGIC SQUARE MIND-READING TRICK

In a magic square the sum of the numbers is always the same whether you add down, across, diagonally, or the four corners. In the top left square, for example, the sum of each set of numbers is *150*. The sum of corner numbers of any two-by-two or three-by-three square is also the same. In the upper left of the same square, the sums of *15 + 28 + 45 + 62* and *15 + 46 + 60 + 29* each equal *150*.

With Graham's nine magic squares (above), you can also appear to read minds. Ask someone to think of a number from *1* to *63* and to place a coin on each of the large squares where that number does *not* appear. Now study the arrangement of coins and in just a few seconds you can determine the chosen number!

The secret is to add the key numbers, the last number in the second row of each *coinless* square. (Coincidentally, it is always the lowest number in its own particular square.) In square number one the key is *12*, in number two *8*, number three, *4*, and so on. The sum of these numbers will *always* be the correct answer. For example, if your subject thinks of the number *57*, a coin is placed on every square except two, six, and seven. Adding the key numbers in those three squares, *48 + 8 + 1*, yields the sum *57*.

READER FEEDBACK QUIZ

Over the past several months, Gamesters have sent us a number of responses to previous columns. We've taken some of their ideas and turned them into a quiz. Answers are on page 111.

Each of the following contributors will receive $10. Anyone who has mind-broadening, thought-provoking tricks, puzzles, or other creative endeavors can submit them to *Omni* Games Editor, 1965 Broadway, New York, NY 10023-5965.

1. In October 1986 we used the words *ideality* and *oxyopia* as examples of the greatest number of syllables with the fewest letters. *Oxyopia* has five syllables in seven letters, or 0.714 syllables per letter; *ideality* has five in eight letters, or 0.625 per letter. Richard Siegelman of Oyster Bay, New York, responded that *area* tops our words. It has three syllables in only *four* letters, or 0.750 syllables per letter. But we can do him one better. What legitimate English word manages a syllables-to-letters ratio of three?

2. W. F. Lundgren of Scottsdale, Arizona, sent this set of five-digit numbers:

1. 23,825
2. 30,038
3. 42,446
4. 58,476
5. _____
6. 52,255
7. 34,333

What should the fifth number be: (a) 57,181, (b) 24,689, or (c) 38,226?

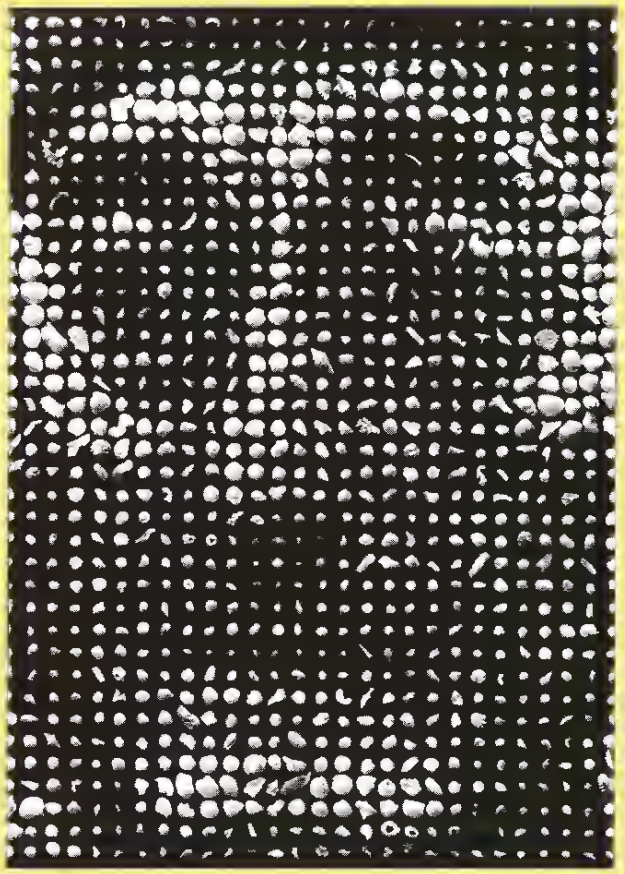
3. From David M. Sweeney of Dallas: On a common digital clock that indicates hours and minutes (no seconds), how many times in a 12-hour period will a time appear with *at least* three of the same digits? For example, 10:00 and 11:21.

4. Ruben Flores of Winston-Salem, North Carolina, has 13 common American coins totaling one dollar. What are the coins?

5. North Station in Boston is the largest railway station in the Northeast, but according to Gordon Hammerle of Adrian, Michigan, it's not the *largest* railway station in Boston. Why? (Hint: English teachers might get this one.)

6. Stephen M. Philbrick of Simsbury, Connecticut, asks: What do the letters in each of these groups have in common?

1. AEFHIKLMNTVWXYZ
2. ABCDEFGHIJKLM NOPRSTUVWXY
3. AHIMOTUVWXY
4. ABEHIKMNOPTX
5. BCDEHIKOX
6. CDILMVX
7. ABDOPQR
8. abdegopq
9. BCDILMNOPRSUVWZ
10. GJPQY
11. ASDFGHJKL



AQUATIC ART

When you walk up to Ken Knowlton's four-by-three-foot aquatic artwork at San Francisco's Exploratorium, you see only a clam shell here, a snail shell there. When you step back about 20 feet, however, the arrangement of seashells and bits of coral begins to resemble a face. Move back another 20 or 30 feet and the face becomes recognizable. It's not just any face, it's a portrait of marine explorer Jacques Cousteau.

A computer graphics consultant whose domino portraits have appeared in previous Games columns (see the March 1985 issue), Knowlton began with a photograph of Cousteau that he digitized and reduced to pixels in shades of gray on a 28-by-38-inch grid. Enlarging it, he then worked to find the optimal correspondence between the cells of the grid and the shells he collected on Vieques Island, off Puerto Rico.

Although you can immediately see the face in the reduction here, you can still experience a sense of the illusion. Prop the page up, and as you move away about 10 to 20 feet, details become apparent in the facial expression, the shadows of the cheeks, the wrinkles around the eyes, even the corner of Cousteau's hat.

Knowlton's *Cousteau in Seashells* is part of the permanent collection of illusion art and other hands-on science experiences at the Exploratorium (see *Omni*, February 1986).

LAST WORD

By Terry Runté

We spend our evenings watching TV made for people who live in trailer parks. It's enough to make you yearn for a fresh start, a chance to build a new civilization from scratch.

It's an experience that has horrified Americans ever since World War Two: You're sitting in the shade at a family reunion on a peaceful summer day, poking at a suspicious lump in the potato salad while some of your screaming nephews stake a niece to the lawn for a game of lawn darts. Suddenly there is a noise. Everyone turns in the same direction. Your face twists into a terrified grimace as a blinding white light washes over your niece, over the potato salad, over you. A single word escapes your lips as you recoil in terror from the light:

"Cheeeeeeeeeeeeese!"

Once again Uncle Kenny has nailed you with that stupid camera he brought back from Hong Kong.

God, I hate people. Every time this happens to me, it makes me wish that some drunken Russian in a missile silo would hit a big red button labeled UNCLE KENNY. While he's at it, he might just as well hit the buttons marked POTATO SALAD, LAWN DARTS, and NEPHEWS.

Let's be real. Prenuclear America has become a drag. We haven't had anything resembling a culture since a bunch of hopheads got together at Woodstock and used up all the good music. We spend our evenings watching television produced for people who live in trailer parks, and Tuna Helper is now one of the four major food groups. It's enough to make you yearn for a fresh start, a chance to plan a new civilization from scratch. It's enough to make you almost look forward to postnuclear life—life after the bomb.

I know I do. I have spent a little time on this. Actually, I spend twelve to fourteen hours a day all alone in my apartment with the shades sealed shut with duct tape, doing nothing but thinking of postnuclear scenarios. Here are some of my favorites:

THE NUCLEAR SUMMER. Carl Sagan and others think a full-scale nuclear war would trigger a nuclear winter and lower the earth's temperature until all plant life dies. That's all very interesting except it conflicts with *my* theory, which I think also has some validity, even though I don't talk like a warped record and wear turtleneck sweaters.

In *my* postnuclear scenario all the dust and the smoke from the burning cities will trap the sun's heat, a phenomenon known as the greenhouse effect. (Is this getting too complicated for you, Carl?) The increased warmth will raise the earth's temperature and turn our planet into a *vaaaast* tropical paradise.

The melting polar ice caps will raise ocean levels and turn my property in Galena, Illinois, into prime beachfront real estate. Women will wear bikinis to their office jobs. People will be able to drink rum and Cokes all year long.

In short, the world will be a perfect place for everyone except guys who wear turtlenecks all the time. Come to think of it, doesn't it make you wonder if this nuclear winter thing is a truly scientific theory at all or just some sort of excuse to keep wearing sweaters?

WIENER WORLD. As a lark I buy an old Oscar Mayer wiener truck, and by sheer luck I am inside, stocking it with wieners, when the big one hits. The lead-coated aluminum hull protects me completely, leaving me the only nonmutant on Earth. I travel the world in my truck, feeding wieners to the dim-witted slugs who used to be humans. In this charred wasteland of civilization I become a symbol of hope, a god, the hot dog, my manna.

THE WORLD OF FORTUNE. A handful of survivors rebuild America's sociopolitical structure based on what they can remember of civilization, which happens to be game shows. In this hellish scenario I of course become a national champion but ultimately lose my bid for world domination when I am unable to tell the difference between quiz-show giants Bob Barker and Monty Hall on a show called *Name That Ancestor*.

SURVIVAL OF THE FATTEST. What if all those loony survivalists are right and they do live on after the blast? After decades of being ridiculed for spending all their money on Uzis and canned goods, they'll probably feel pretty smug when the smoke clears and they emerge from their shelters. They'll no doubt all be grinning and patting one another on the back. Maybe do a little victory dance around their fallout shelters.

Then they'll realize they forgot to pack a can opener and won't be able to eat any of their food.

Now I of course will have one: a huge, gleaming gold-plated beauty of a can opener. And when they come scratching at my door pleading for mercy, their voices getting drier and weaker by the day, I'll just laugh. Then, at the last minute, I'll fling the door open and rescue them. They'll make me their general, and together we will rule the earth. All mankind will tremble before the specter of my all-powerful can opener.

MASS TRANSIT HEAVEN. Everyone on Earth dies except me and the employees of the subway system, which remains intact. I find it a little eerie at first, knowing that a whole fleet of empty trains hurtles under the city streets hoping to find me waiting at some stop. But it's great. I can get anywhere in town in eight minutes, and I always get a seat.

MASS TRANSIT HELL. Same as above except that I use my last token just before the bombs drop. ◻◻

Terry Runté is a humor writer who lives peacefully and securely in Chicago in an apartment with eight-foot-thick concrete walls.