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JULY 1991

SPACEWARD HO!

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VOL 13 NO 10 JULY 1991

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8
First Word
By Roald Sagdeev
The light of *glasnost* has revealed a Soviet space program badly in need of rejuvenation. But the Soviet Union's economic crisis warns this ex-Soviet space official, may force the public to choose between food and rockets

9
Omnibus
The Who's Who of contributing authors

10
Communications
Readers' writes

12
Space
By Jerry Grey
Having mastered the art of gradually cornering vulnerable high-tech markets, Japan turns its attention to the commercial space arena. It's learned how to be a contender without being a big spender

Do we still dream eagerly of space travel? Of great vessels voyaging between worlds and among the stars? Cover artist Chris Moore certainly has such dreams. Where are Moore's spacecraft bound? Hard to say. But at least they are unbound by gravity, their great energies free to strain toward distant frontiers. (Additional art and photo credits, page 84)

14
Transportation
By W. E. Gutman
If it's three o'clock, this must be Spain. Travelers will zoom in comfort through Europe on a high-speed rail network now on the drawing board

18
Earth
By Shari Rudavsky
The world's oldest living giant trees stand deep in a Chilean forest, but their days may be numbered.

20
Books
By Patricia Barnes-Svarney
The profits from Project Solar Sail will help send solar sails to the moon

25
Continuum
Vindicating vegetarianism, beware the monster sand dunes, the toilet plunger—out of the bathroom and into the operating room and more

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OMNI

34

Rim Shots
By Tom Dworetzky
Considered too remote for the Apollo program, the Pacific Rim has become the hot spot for spaceports in the works. But a boom in space launches in the Pacific could sound the death knell for the U.S. space industry.

50

The Greenhouse Effect: Apocalypse Now or Chicken Little?
By Robert Silverberg
While the scientists predict that the most drastic results of the greenhouse effect won't be felt for some years, a lot of people are already getting hot under the collar. Taking a look at the planet's periodic climate changes might help them—and the earth—cool down.

56

Pictorial: Lost Ark
By Sandy Fritz
Where the wild things are. Drawing the animals one by one, Dugald Stermer creates a naturalistic Noah's Ark.

62

Interview
By Kathleen McAuliffe
W. French Anderson has not only unlocked many of the secrets locked in DNA; he has also put them to practical use.

67

Fiction: Stigmata
By Robert Frazier
Deep in the tangled, vibrant rain forest, a man struggles to escape his memories of a lost love and searches for truth.

75

Antimatter
A UFO unites contentious Belgium, vampire bats may be moving to Florida, but they're not refining; a modern-day Dracula and the original's stolen ring, and more.

98

Star Tech
Tools for the twenty-first century.

100

Video Games
By Bob Lindstrom
A look at the new game systems shows that undisputed champion Nintendo has some serious challengers. The quality and availability of games will determine which systems can go the distance.

102

Games
By Scot Morris
At a puzzle convention, enthusiasts display the latest unconventional creations.

104

Last Word
By Stan Sinberg
There are no new ideas, only old radio waves masquerading as new ideas.

42

Spaceward Ho!
By Ben Bova and Stephen L. Gillett
The covered wagons may look a little different, but we'll settle space much the same way we did the Western frontier—with the government leading the way. Private industry will need federal help to develop space, just as it did to build the West's railroads and dams.

FIRST WORD

SOVIETS IN SPACE

The people and their deputies hold the key to the USSR's initiatives

By Roald Sagdeev

Roald Sagdeev is former director of the Soviet Institute for Space Research.

The emergence of *glasnost* surprisingly, made space exploration one of the fields most vulnerable to criticism in the Soviet Union. For several decades, since the launching of the first artificial earth satellite, space activities were considered to be extremely successful in the Soviet Union. Yet in the years since *perestroika,* political leaders have used space research as an example of how the Soviet system has failed.

There are a variety of explanations for this paradox. First, when the Soviet people rejected the legacies of the stagnant Brezhnev era, we automatically rejected everything from that time in history, including some of our successes.

In addition, after leading political figures abandoned the Soviet space agenda several years ago, space efforts slowly eroded. As talented builders and enthusiastic scientists withdrew from the space program, conceptual and intellectual leadership fell into the hands of party clerks and bureaucrats. The assessment of space vehicles was then performed behind closed doors by a few people, people who made bad decisions. The clearest example of party bureaucracy was the decision to develop the Buran system, practically a copy of the American shuttle program.

It is now common knowledge that more than half of the Soviet space budget goes to the military space industry. The balance goes to Buran, the civil space industry, and to space research. The budget for research projects in space, unfortunately, is on the order of one, or one and a half, percent of the entire annual space budget. In addition, the budget for Soviet civil space science is no more than one tenth of the U.S. space budget.

During the last 10 or 15 years, the primary goal for those scientists still involved in the space program was merely to survive; no great accomplishments were made because there was no opportunity for achievement.

However, astronautics opened up wide avenues in some areas of science. We can now study the solar system with sensitive probes and launch increasingly powerful and complicated telescopes into orbit. Although rocket carriers have become increasingly varied, and we have devised ways to send heavy vehicles out of the atmosphere surrounding the earth, in no way did the Soviet space program succeed in fulfilling the potential of astronautics. We dragged our feet around Venus for 15 years, and thanks only to the continued enthusiasm of some scientists and researchers, we encountered Halley's Comet.

At the end of the Seventies and the beginning of the Eighties, the location designated for a Soviet meteorological satellite, under the international program for meteorological observation, remained empty. As a consequence, this location was eventually reassigned to an American satellite. And to date we cannot compete on the world market with scanning devices like those used in the international system such as Landsat or the French Spot.

What steps should be taken to improve and utilize the Soviet space initiative? Personally, I think that under no circumstances can the Buran program ever be economically profitable. I believe that in the next few decades, any multiuse space transport will not be able to seriously compete with one use rockets.

To accelerate financing of the program, when the country is in the throes of economic crisis, is impossible. Further imposing this unreasonably expensive program on the people can only accelerate the negative attitude that has developed in regard to astronautics in the eyes of the public.

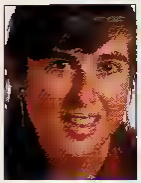
A dramatic change must occur. Discussion of space policy must no longer be limited to a few government personnel, or even to the scientific or military communities. The Soviet commitment to space must move to the corridors of the Deputy Assembly and Supreme Soviet, where the people's elected deputies can contribute to decisions regarding the Soviet Union's future in space.

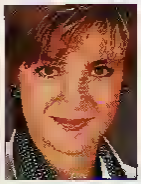
We should open up the Soviet space program to public scrutiny, show the people what it contains and let them weigh the pros and cons. When given the opportunity to influence decisions important to the economy and to science, the people will undoubtedly make choices worthy of the country that launched the first satellite into space.

The exploration of space is a valuable endeavor, but the time has come for us to think seriously about the fact that today supplying the country with badly needed essentials such as food and disposable syringes may be more important than creating new space rockets. ∞

OMNIBUS

AIMING FOR PACIFIC HEIGHTS:
Our intrepid writers say aloha to the mainland, seeking otherworldly ports of call





From top, Shari Rudavsky, Kathleen McAuliffe, Tom Dworetzky, and W. E. Gutman.

Not only will space exploration evolve into an international commercial venture, but missions may very likely launch from Pacific Rim spaceports. Indeed, efforts underway in Australia, Hawaii, Japan, and other Pacific locations will eliminate, or at least reduce, bureaucratic red tape. "Space exploration is too big a challenge for any single nation," says *Omni* contributing editor **Tom Dworetzky** ("Rim Shots," page 34). "And developing space programs in the Pacific will help free the human migration to space." Envying Toyohiro Akiyama, the Japanese journalist who joined the cosmonauts aboard the Soviet space station *Mir*, Dworetzky proclaims that he'd be the first person in any emigration line and wouldn't care what country's flag was pinned to the spacecraft.

President of the Science Fiction Writers of America (SFWA), **Ben Bova** ("Spaceward Ho!," page 42) is a former president of the National Space Foundation, and former *Omni* editorial director. Tor Books recently published the paperback edition of Bova's novel *Orion in the Dying Time*. Geologist **Stephen L. Gillett** ("Spaceward Ho!," page 42) has written numerous scientific papers and contributed to the pages of the science-fiction digest *Analog*.

Science-fiction author **Robert Silverberg** ("The Greenhouse Effect: Apocalypse Now or Chicken Little?," page 50) has written numerous nonfiction books on topics ranging from archaeology to the global climate. His most recent novels include *The New Springtime* (Warner) and *Nightfall* (Doubleday), a collaborative effort with Isaac Asimov.

When writer **Kathleen McAuliffe** and her sister tackled the possibilities of genetic engineering in their 1981 book, *Life for Sale* (Coward McCann & Geoghegan), gene therapy was considered a far-fetched idea. In this month's Interview (page 62), however, McAuliffe speaks with the first surgeon to treat humans with genetically altered cells. McAuliffe is a former senior writer for *U.S. News and World Report*. Her work has also appeared in *Reader's Digest*, *The New York Times Magazine*, and others.

While researching Earth's vanishing paradises for *Omni*'s September 1990 issue, *Omni* contributing editor **Shari Rudavsky** (Earth, page 18) stumbled upon an organization working to preserve Chile's little-known temperate rain forest. "Here I was pursuing doom and gloom, when it occurred to me that the Chilean rain forest was well on its way to becoming a future horizon, not a forgotten one," says Rudavsky, who attends graduate school at the University of Pennsylvania.

Omni international editor **W. E. Gutman** (Transportation, page 14) is familiar with many modes of travel, including France's Train a Grande Vitesse, or TGV. While he clocks more than 50,000 air miles per year, Gutman has also traveled by less trendy tramp steamers, dromedaries, and recalcitrant mules.

A past president of the International Astronautical Federation, **Jerry Grey** (Space, page 12) is director of science and technology policy at the American Institute of Aeronautics and Astronautics.

Winner of a Rhysling Award for Best Short Poem of 1989, **Robert Frazier** (Stigmata, page 67) is one of science fiction's foremost poets. He and Bruce Boston cowrote *Chronicles of the Mutant Rain Forest* (Mark V. Ziesing, fall 1991), a volume of poetry set in the same milieu as "Stigmata." The book's proceeds will benefit rain forest conservation.

And kudos to **Ted Chiang**, recently awarded a Nebula for his first published story, "Tower of Babylon" (*Omni*, November 1990). "It makes you glad you're in the business. A fresh talent appears out of nowhere and reaps a top honor in the field," says Ellen Datlow, *Omni* fiction editor and coeditor of the fourth annual collection of *The Year's Best Fantasy and Horror* (St. Martin's Press). ∞

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JULY

COMMUNICATIONS

READERS' WRITES

Looking eastward to Japan, virtually dreaming of Tahiti, and banking on the Airbus

Smart Dividends

Erich Bloch's First Word [April 1991] seems to answer the question that was asked in a cartoon in the same issue: "You still wonder why Japan is ahead of us?" While the United States was making its smart bombs, Japan was busy making its smart cars, smart televisions, smart microchips, smart real estate investments, and other smart investments. The difference is not in the quality or quantity of smartness, but in its direction. To get the full value of the peace dividend, our Cold War patriotism should be directed into high-tech research and development. Let's give future generations a dividend instead of a debt.

Kenneth J. Epstein
Chicago

Being There

Author Gregg Keizer ["As Good as There," April 1991] didn't take his televirtuality scenario quite far enough. In my office of the future, I live in Tahiti. My job market is worldwide, but I work in virtual reality (VR) New York. At 7:55 A.M. I'm sipping coffee in Tahiti. At 8 A.M. I don my VR suit and enter my VR office in VR, NY. I shuffle through my VR mail, then wander into a colleague's office for a three-way televirtuality chat. When it's time to eat lunch, I'm sitting on the real sand in the real Tahiti. What a wonderful life!

Roger A. Bruno
Portland, OR

Back to You, Bob

Although a great concept, "Gourmet Garbage" [Continuum, April 1991] is not a new idea. More than 40 years ago, radio comedians Bob Elliott and Ray Goulding (also known as Bob and Ray) wrote and performed a bit they titled "Edible Food Packaging." It was even included in their 1983 Atheneum book *From Approximately Coast to Coast: It's the Bob and Ray Show*. I am sure Bob (Ray died last year) would appreciate the credit.

Steven Lance
Howell, NJ

Pregnant Thoughts

Congratulations are in order for Barry N. Malzberg's "What I Did to Blunt the Alien Invasion" [April 1991]. Malzberg uses ideas, subjects, and techniques that cry out for synthesis. The story would make a great novel.

Dennis M. Zogbi
Northport, NY

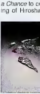
User-friendly Skies

Shame on your aviation "expert" Martin Caidin for joining the sensationalist supermarket tabloid mentality regarding "unsafe" fly-by-wire systems coming onto the aviation market [Transportation, April 1991]. I am a pilot for a major U.S. airline. To date, no aircraft accidents have been blamed on computer glitches. But one famous accident might have been avoided if only the aircraft had had a fly-by-wire system. The crash of a United DC-10 in Sioux City, Iowa, was due to a catastrophic engine failure that severed the hydraulic lines to the flight controls. With a fly-by-wire system, the pilots probably could have maintained total control of the airplane and landed safely. There will always be inherent risk in any technology, but fly-by-wire, in this airline pilot's opinion, makes the skies safer.

Eric Auxier
Scottsdale, AZ

Correction

The credit for the cover of the May 1988 issue of *Omni* should have read as follows: Cover photograph part of a series taken for the poster *Give Peace a Chance* to commemorate the bombing of Hiroshima. The poster is part of the permanent collection of the Hiroshima Modern Museum of Art Art/Design. Minoru Morita, Glass Sculpture. Milon Townsend, Photography. Kan Nakai, Copyright 1985 Minoru Morita. DO



SPACE

A YEN FOR SPACE

Japan's going a long way on just a little money

By Jerry Grey

Space—the final market: Japan aims to conquer the ultimate frontier with the same strategies that won it the consumer electronics and computer markets.

Over the past few decades, the United States has lost some of its most technologically important and profitable markets to Japan. Now space experts wonder if perhaps the commercial space market will be going the way of automobiles, consumer electronics, and computers—to the Land of the Rising Sun.

A glance at the financial picture is misleading. Japan spends a paltry $1.5 billion a year on space, while the United States invests about $35 billion. Even China has looser purse strings than Japan, pouring about $3 billion annually into space. And with an annual outlay of $4 billion, nearly triple Japan's budget, Europe seems more worrisome.

The financial bottom line, however, doesn't tell the whole story. Little of Japan's space budget goes toward military space systems, which gobble up more than half the U.S. space budget. And the Japanese government spends far less than the United States or Europe on such infrastructure elements as space stations.

Instead, Japan aims its yen much more precisely at marketable products and services like satellite communications, which makes up today's largest commercial space market. Although U.S. firms built Japan's first few generations of commercial communications satellites, each new satellite generation incorporates more indigenous technology.

More important, Japan has invested heavily in technologies that have little commercial value now but whose potential is tremendous. As a result, it has leapfrogged the Western nations in tomorrow's products, direct broadcast systems for high definition TV, high-frequency personal-communications satellites (like the *Dick Tracy* wrist radio), fiberoptic links with ground-based communications networks, and low-cost high-performance receiving antennas, already the largest commercial hardware market in satellite communications.

Another key strategy is the teaming of government and industry to develop commercially important technologies. For instance, in 1986, seven of Japan's largest companies created the Space Technology Corporation. Under the umbrella of the government's Ministry of International Trade and Industry (MITI), it has coordinated Japan's efforts in microgravity research, which could spawn enormous markets. Last year two new consortia were formed: the 70-company Rocket System Corporation, to market Japan's new H-II launcher, and the Japan Manned Space System Corporation, which counts five of the world's largest banks among its 60 members.

This flurry of activity in areas of space technology that have yet to generate their first yen, resembles MITI's teaming of Japan's eight largest electronics firms in 1961. They set out to develop random-access memory chips for a then-nonexistent computer market. Today they dominate the world market.

Japan's past market conquests came not from huge budgets but from judicious application of these same strategies. So although Japan doesn't spend nearly as much as other spacefaring countries on its space programs, the allocation of its expenditures may very well prove to be wiser.

Fortunately, the United States seems to have finally learned its lesson from Japan. For example, NASA's Office of Commercial Programs has accelerated its excellent program to pinpoint commercially promising technologies and products and to foster government–industry–university cooperation. If our policymakers prove successful in promoting this trend, there's hope that the United States can continue to be competitive in space. ∞

TRANSPORTATION

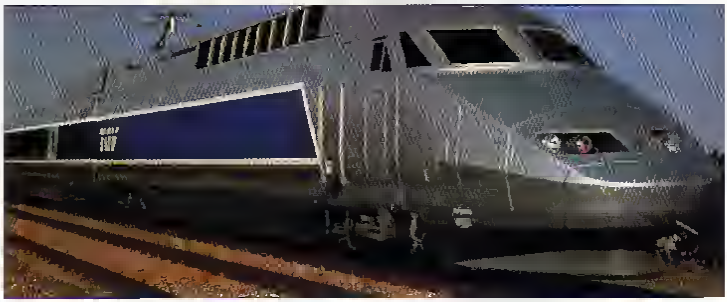
THE EUROPEAN EXPRESS:
France's superfast train could zoom your way

By W. E. Gutman

Traveling through Europe by train can be slow, inconvenient, and, depending on the country operating the train, uncomfortable. All that will change, however, if a high-speed rail network now on the drawing board becomes a reality.

Developed by France's state-owned railway, the Société Nationale des Chemins de Fer (SNCF), for the French Ministry of Transportation, the plan calls for 20,000 miles of high-speed track to be laid between Europe's principal cities by the year 2015. Many of the trains would run at speeds faster than 220 miles per hour, in many cases halving travel time between cities. For example, traveling from Paris to London via the soon-to-be-completed Channel Tunnel would take only two hours and ten minutes.

The train that beats the plane: France's high-speed Train à Grande Vitesse



lures travelers away from airlines with luxurious cars and low fares

The SNCF estimates that 50 million travelers per year will avail themselves of the high-speed rail network, siphoning passengers from the airlines. "The new Europe is politically committed to a widening of its mass transport infrastructure," says Bernard Riehl, commercial attache at the French embassy. "This, coupled with wide public support for an energy-efficient mode of travel, will sharpen competition on short- to medium-distance routes."

More than likely, the high-speed trains crossing Europe in the next century will be updated versions of the SNCF's own Train a Grande Vitesse (TGV), an overwhelming success since its inauguration in 1981. The world's fastest train in commercial service, the latest model of the TGV streaks along at 186 miles per hour between Paris and cities on the French coasts and along France's eastern flank. In addition, the TGV's ticket prices beat those of France's domestic airline by as much as 50 percent.

Built by GEC Alsthom, the current model of the 490-ton electric train is 40 percent more powerful than the initial TGV models that still run from Paris to Lyons at an impressive 168 miles per hour, outpacing Japan's 130-mile-per-hour Tokyo–Osaka bullet train.

GEC Alsthom and the SNCF have taken great pains to prevent the TGV from disturbing the French countryside it traverses: building deer crossings and erecting sound barriers in certain areas, for example. In France's famed Loire Valley wine country, rubber padding lines the train tunnels to keep the vibrations from reaching delicate vineyards and wine cellars.

But the TGV's greatest virtues are its quiet ride and amenities. Passengers can easily take notes, undisturbed by bumps or jolts. Each of the train's ten elegant cars has a phone, and many cars have small compartments reserved for business meetings.

Other parts of the world will soon be able to sample the TGV's advantages. GEC Alsthom and Canada's Bombardier Corporation have signed a marketing and manufacturing agreement for the TGV in North America, where it is being considered in tentative plans for numerous high-speed rail lines, including those between Toronto and Montreal, and Miami, Orlando, and Tampa.

Meanwhile, scientists are working to make the TGV even more efficient, designing a double-decker train that will increase passenger capacity from 485 to about 730 per train. They're also trying to raise the TGV's operating speed. "There are virtually no technical impediments to achieving higher commercial velocities—only economic ones," like electricity consumption, says Pierre Galaud, vice president for marketing at GEC Alsthom's U.S. subsidiary.

"The TGV has demonstrated that proven rail-wheel technology can provide a wide margin of safety and is capable of still greater speeds without resorting to exotic or untried transportation systems," Riehl says. Such alternative systems include magnetic-levitation trains that use the force of repulsion between negative and positive magnets embedded in the track and in the train, to suspend the train inches above the track. The few existing commercial mag-lev rail lines using conventional magnets run at low speeds and cover only short distances. Japan, meanwhile, is concentrating on superconductive mag-lev trains, which are not expected to enter service until well into the twenty-first century. ◻◻

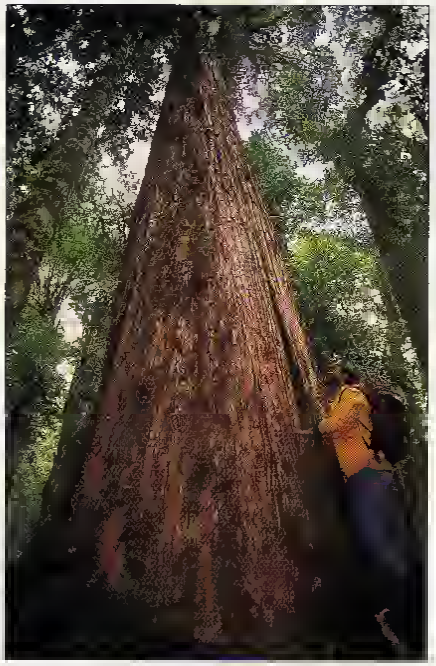
EARTH

OUT ON A LIMB
Environmentalists rescue an ancient forest

By Shari Rudavsky

The story reads like a conservationist's fairy tale. Deep in the woods of Chile stand some of the oldest living trees on Earth, older than even the California redwoods. A redwoods activist hears the legends of these majestic trees and sets off to Chile to try to locate them. His quest, marked by several trips through the Chilean wilderness, ends after 13 years when he comes upon a cathedral forest of the elusive ancient trees, called alerce, in an area virtually untouched by man.

Today the hero of this true-life tale, Richard Klein, is spearheading a movement to save the ancient forests of Chile—home to the alerce, a tree that lives as long as 4,000 years, and the araucaria tree, a species that's at least 200 million years old. The alerce is a cedar closely related to the giant sequoia. Although little is known about it, botanists consider the alerce the oldest giant tree on Earth, second in age only to the Pacific Southwest's bristlecone pine.



Thanks to a group of redwood activists, Chile's alerce tree will be spared the ax.

But just as this story has its heroes, an international group of conservationists, it also has villains: wood chipping companies whose workers chip away at the trees until there is nothing left but stumps.

Three years ago Klein started Ancient Forest International (AFI) to save the world's endangered redwoods. Because of the immediate threat to the alerce and araucaria trees, AFI now concentrates its efforts on the Chilean forests, which constitute a mirror biome of the Pacific Northwest forests. "We're the primary group in North America concerned with one of the two greatest temperate rain forests on the planet," says Klein. "We must save what's left, especially the most superlative examples of life."

Because land in the Chilean forest can cost a fraction of equivalent land in North America, wood chipping companies have flocked to the area. The araucaria and alerce trees are protected by the government, but they live within the mixed hardwood trees that the wood products companies seek. Wood chipping in these areas could destroy the alerce and araucaria's habitat.

The low price of Chilean land, however, also holds the key to the problem. AFI and other groups have devised a plan that follows the U.S.-based Nature Conservancy blueprint. Raise money to purchase the land for international sanctuaries. "I can't afford to save the redwoods because land values in the Pacific Northwest are so high," says Ami Goldberg, AFI administrator. "But in Chile you don't need to be rich to save an acre of land."

The organizations have laid the groundwork for an araucaria preserve. AFI has raised more than $100,000 to buy the 1,000-acre Cañi araucaria forest, currently owned by a Chilean environmentalist who purchased the land as a temporary measure to save the trees from the chopping block. Assuming AFI can raise the additional $70,000, AFI's Chilean associate, Fundación Lahuan, will receive title to the land this year.

In addition to the Cañi preserve, Fundación Lahuan and AFI are attempting to establish an alerce reserve around the Cahuelmo Fjord, known in Chile as "The Place of the Dolphins." Accessible only by foot, Cahuelmo boasts miles of untouched alerce. Depending on how much money it can raise, AFI hopes to purchase between 5,000 and 500,000 acres of alerce habitat to create a world park in the fjord region, nicknamed the Yosemite of the Southern Hemisphere.

The bulk of support for these projects comes from the corporate sector, but AFI has also received contributions from "little kids who empty their piggy banks," Goldberg says.

AFI also focuses attention on the Chilean forests by conducting scientific expeditions into the rain forest. More than 150 scientists, journalists, and conservationists accompany the AFI staff on these monthlong treks to expand scientific knowledge of Chile's indigenous trees.

Through these efforts, the organization hopes to engender a sense of responsibility for the global environment. "We feel that a tree is a tree and borders don't matter," Goldberg says.

BOOKS

GONE WITH THE SOLAR WIND
Sometimes all you need is a light push

By Patricia Barnes-Svarney

With money for space exploration in short supply the nonprofit World Space Foundation has turned to the written word to bankroll an unusual project.

The foundation hopes that its book *Project Solar Sail* (©1990 ROC, $4.50) will not only generate enough cash to help underwrite its project but will also rally support for a little-known, theoretical manner of space travel—"sailing" on beams of sunlight.

The idea of using a saillike sheet of material to travel through space was first proposed in 1924 by a pair of Russian engineers, Konstantin Tsiolkovsky and Friedrich Tsander. The concept is simple enough. Light particles called photons can exert gentle pressure on a reflective saillike object, pushing it away from the sun the way wind pushes the sail of a ship. But unlike the fickle wind, light steadily streams from the sun, supplying an abundance of propellant at zero cost. Robert Staehle, World Space Foundation president, says that the sails now under development will achieve modest top speeds of 75,000 to 100,000 miles per hour, but he adds that the speed potential for future-generation sails will be far greater.

That's the idea at least. Whether or not the idea lives up to expectations should be made clear by a solar sail race to the moon slated for 1994. "It's a race all right," Staehle says, "but a race of the crudest sort, like an airplane race in 1903." The foundation's entry, the only American sail in the race, will compete against an entry from the Union pour la Promotion de la Propulsion Photonique (U3P), a French and Spanish consortium, and another from Japan's Solar Sail Union. Plans call for the trio to be launched aboard an Ariane rocket. After unfurling in space, the first craft to send photos of the moon's far side back to Earth wins. The foundation's craft will then slingshot around the moon and set course for a three-year journey to Mars.

The kite that might: A cheap mode of space travel could open the solar system to further exploration.

The plans are ambitious. But the search for funding—from corporations and other sources—produced mixed success. So when Bob Cesarone, a trajectory engineer at NASA's Jet Propulsion Laboratory and a foundation staff member, suggested putting together a book and using the advance and royalties to fund ongoing expenses of the project, the group cheered. "We asked the writers to give us stories, not money," says Cesarone. While purchasers of the book will be contributing to getting the vessel aloft, the book's proceeds will cover only a fraction of the $4.5 million it will cost to build the solar sail. "But it's helped us generate money at a critical stage of the project," Staehle says.

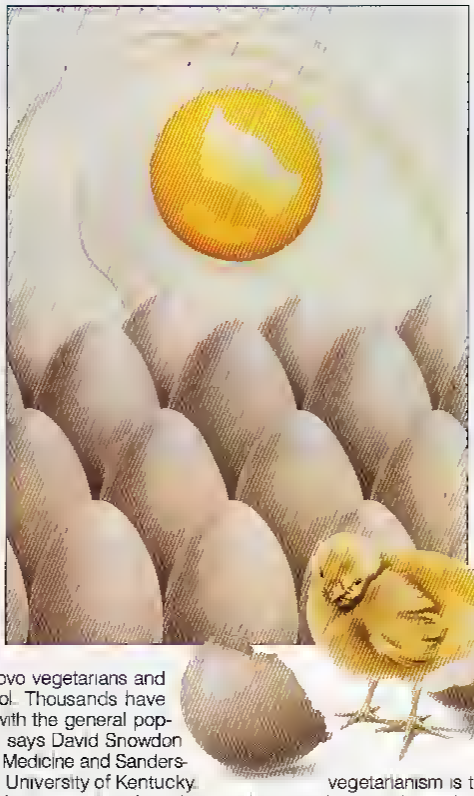
Project Solar Sail, a mixture of fact and fiction by such authors as Arthur C. Clarke, Isaac Asimov, and Ray Bradbury, traces the real and fictional development of the lightweight sails. The project has not only helped ease the cash flow problem but also helped to clarify the foundation's goals. "The book has been good for our morale," Staehle says. "It has also forced us to articulate on paper some of the directions that solar sailing may take us, something many of us never had to do before. Now we are firmly fixed on flying the spacecraft, learning how to sail in space, and knowing where it will lead us."

One of the chapters describes the enormous benefits of developing armadas of solar sails to further space exploration. "To send humans to Mars, you would have to send equipment, water, supplies, and fuel," says David Brin, the book's editor. "Solar sails will be an inexpensive way to ship the hardware years before we launch the people. Just send the sails and park them in orbit. If space travelers found they didn't need everything and came back to Earth, there would be all that equipment, fuel, and water tempting us to go back." OO

CONTINUUM

VEGETABLE MATTER

Meat lover, change your eating ways. Plus, rebuilding the desert shield, and why Fido won't shut up



It's a good time to be a vegetarian. And at the risk of sounding smug, I admit that what is on the minds, if not the tongues, of many of us is "I told you so." Over the past two decades nutritional and biomedical research has shown in hundreds of studies not only that it is possible to be a well-nourished vegetarian, but also that vegetarians experience lower rates of disease and live longer than meat eaters. That's something to crow about.

Although many dietary regimens sail under the vegetarian flag, the two main types are vegan and lacto-ovo. Lacto-ovo vegetarians are by far the most numerous. They avoid meat, fish, and fowl but eat dairy products and eggs. Vegans eliminate eggs and dairy.

We can thank the Seventh-day Adventists, a conservative Christian group formed in the nineteenth century, for much of what we know about vegetarian diets. Roughly half of Adventists are lacto-ovo vegetarians and make for an ideal subject pool. Thousands have been studied and compared with the general population over the past 25 years, says David Snowdon of the Department of Preventive Medicine and Sanders-Brown Center on Aging at the University of Kentucky.

Snowdon's work has shown that vegetarians have lower blood pressure and cholesterol than meat eaters. They are also less prone to diabetes and prostate cancer. They experience less obesity, and their rates of heart disease are lower than those of the general population. Vegetarians *do* live longer. Why?

"Coronary heart disease and stroke are the major killers," Snowdon says, "and the determinants of how long people live." Since vegetarians tend to eat fewer calories than omnivores, they are slimmer, which results in lower blood pressure and cholesterol, and less diabetes, "all of which are risk factors for coronary heart disease and stroke," Snowdon says. What's more, vegetarian diets are lower in saturated fat and higher in fiber, and their high vegetable intake provides more of substances such as beta carotene that are protective against cancer.

To meat eaters, Snowdon suggests cutting back even a little, on steaks, burgers, and chops. As people consume less meat, the threat of coronary heart disease goes down, as does the risk of diabetes. "Everyone," Snowdon says, "can benefit from moving a bit along that dietary continuum." Vegetarianism is not simply an either/or proposition.

Suzanne Havala, author of the American Dietetic Association's 1988 position paper on vegetarian eating endorses "a well-planned" vegetarian diet. So why aren't we being urged by the medical community to make the switch? Havala thinks that part of the problem is that vegetarianism is too foreign to Americans. Ours is a meat-based culture, she says, "and vegetarian diets are just un-American." Don't underestimate the meat industry either, she cautions. It has political clout. But Snowdon says he's hopeful. The dietary guidelines coming out of the National Institutes of Health and the National Academy of Sciences over the past ten years suggest that people cut down on animal products and eat more fiber, fruits, and vegetables. That sounds suspiciously like gradual vegetarianism to Snowdon. It's a slow process, he says, "but little by little many people will approximate a vegetarian diet." See you in the produce section.—*PAUL McCARTHY*

CONTINUUM

Every time Bossy belches, methane rises into the atmosphere—and hangs around to heat up the earth for more than 12 years, even longer than researchers thought

GAS THAT WON'T GO AWAY

Researchers have discovered some good news and some bad news about methane, a gas that contributes to the greenhouse effect. The good news: We're emitting less methane than scientists have previously estimated based on the concentrations of methane in the atmosphere. The bad news: The methane emissions linger in the atmosphere longer than researchers thought.

A. R. Ravishankara and G. L. Vaghjiani of the National Oceanic and Atmospheric Administration's Aeronomy Laboratory in Boulder, Colorado, found that the naturally occurring hydroxyl radical reacts with methane to dissipate the gas about 25 percent more slowly than earlier studies had shown. So methane stays in the atmosphere not ten years, as previously estimated, but more than 12 years.

Scientists have based their estimates of worldwide methane emissions on the gas's concentration in the atmosphere and the accepted rate at which it reacts with hydroxyls. Ravishankara and Vaghjiani's findings indicate that a smaller amount of methane that lasts longer accounts for the concentration. The researchers say that the earth is thus emitting 100 billion fewer kilograms a year of methane than was thought. Efforts to curb methane emissions, therefore, may have a correspondingly greater effect on atmospheric warming. "The amount of methane in the atmosphere is now increasing at one percent a year," Ravishankara says. "We could try to reduce that to zero."

An international research panel estimated that 15 percent of the energy radiating from Earth is trapped by atmospheric methane, which is also known as swamp gas. Methane is produced not only industrially, but also organically by such sources as wetlands, rice farms, landfills, sheep, cows, and termites. —John Voelcker

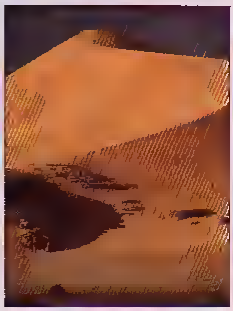
"Every man loves and admires his own country because it produced him."
—Edward Bulwer-Lytton

BECAUSE THE DISEASE WAS THOUGHT TO BE INFLUENCED BY THE STARS, IT WAS NAMED INFLUENZA IN THE MIDDLE AGES.

THE BIG SQUEEZE

At Cornell University, physicist Arthur Ruoff and his research team know all about high-pressure science. They claim to have produced the greatest sustained static pressures ever achieved in a laboratory.

By squeezing a sample of molybdenum powder in the jaws of a diamond anvil, Ruoff and his team registered a sustained pressure of 4.16 megabars, greater than the



Giant sand dunes are swallowing cities in the Middle East

ATTACK OF THE KILLER DUNES

Sand dunes and sandstorms could engulf roads, plantations, airports, or even whole villages in

3.6 megabars pressure at the earth's core. The result created a solid form that doesn't usually exist at surface pressures. "When you squeeze a substance really hard, you change the distance between atoms," says Ruoff.

"This research could enable us to test theories about the atomic structure of matter," he adds. The group's high-pressure studies could yield valuable insights into the structure of the earth and other planets, findings that could ultimately lead to a better understanding of the origin of the universe.

—Kathleen McAuliffe

"If you want your name spelled wrong, die."
—Al Blanchard

ABLE BUT NOT WILLING

The biblical command to go forth and multiply apparently never reached the pink lady's slipper, an orchid native to the forests of the eastern United States.

After studying 3,000 of the orchids in a Virginia forest for 14 years, Doug Gill, a zoologist at the University of Maryland in College Park, discovered that only 1,000 plants had flowered and just 23 had been successfully pollinated. "This is an astonishing failure rate," he says.

Although the flowers are fertile, Gill found, they discourage reproduction at every step. Most flowers attract pollinators through irresistible colors or by offering a reward, like nectar, or a tantalizing aroma. But pink lady's slippers produce no nectar, instead attracting bees by subterfuge, hinting at the presence of nectar but delivering none. Adding insult to injury, the bee must descend into the flower's folded petals, which then close even further to trap the bee. The insect eventually escapes with a blob of pollen, but it seldom returns to repeat the ordeal.

Many other species of orchids don't offer nectar but can reproduce by pollinating themselves. Gill believes the pink lady's slipper is purposely repressing its own propagation, an extremely unusual occurrence. So how does the plant persist? For one thing, each produces about 60,000 seeds when successfully pollinated. "These plants enjoy virtual immortality," Gill says. "They have no enemies, and they live twenty-five to thirty years."

—W. E. Gutman

A flower with a death wish? The long-lived pink lady's slipper orchid sabotages its own reproduction at every turn.

"Everyone thinks of changing the world, but no one thinks of changing himself."
—Leo Tolstoy

war-ravaged Kuwait, southern Iraq, and northeastern Saudi Arabia.

The construction of countless bunkers and military installations, as well as the Allied and Iraqi bombing raids during the Persian Gulf War, left thousands of craters in the desert. By removing the natural "desert shield," small rocks and pebbles that cover the sand, the military's action increased the formation of sand dunes, explains geologist Farouk el-Baz, head of Boston University's Center for Remote Sensing. The desert's near-constant winds blow newly exposed sand into dunes that can grow as high as 200 feet.

The dunes creep at a rate of up to one foot per day. El-Baz learned while tracking dune movement by plane and satellite in Egypt and Kuwait from the Seventies onward. Moving slowly but relentlessly, the sand can eventually swallow an entire city. "People have to leave, because the sand keeps piling up higher and higher," El-Baz says. "It's not like a blizzard you can dig out from." In western Egypt in 1979, the government had to build new villages to replace those buried in sand.

El-Baz recommends filling in the holes left in the desert as the most effective way to discourage the formation of the enormous dunes. —Steve Nadis

NINETY-NINE PERCENT OF ALL FORMS OF LIFE THAT HAVE EXISTED ON EARTH ARE NOW EXTINCT.

FROM AGE 20 TO 70, THE TYPICAL PERSON SPENDS ABOUT 600 HOURS HAVING SEX.

CONTINUUM

Plop, plop. The sounds made by raindrops hitting the water reveal a wealth of information about the weather.

SINGING IN THE RAIN

Coming soon, the music of the Screaming Infant Microbubbles. You won't find it on CD, but scientists like Herman Medwin of the Naval Postgraduate School in Monterey, California, are tuning in the music of the spheres—tiny bubbles suspended near the ocean's surface that indicate what the weather is like at sea.

When raindrops hit water, Medwin says, they create tiny bubbles that emit high-pitched sounds. Impact makes the bubbles pulse violently during their "screaming infant" stage, a fraction of a second. Then they settle into a more quiescent "adult" bubblehood.

The pitch of the bubbles' sound is directly related to the bubbles' size and the angle and velocity at which the raindrops hit the water. "Rain, hailstones, even snowflakes, each have their own signature sound," says Lawrence Crum, director of the National Center for Physical Acoustics. The differences in pitch can reveal information about air temperature above the ocean as well as wind speed since raindrops that hit obliquely make a slightly different sound than those that fall vertically.

By deploying arrays of sonobuoys over large areas of ocean, climatologists hope to get more accurate readings of weather systems than they now get from satellite photographs alone.

—Khephra Burns

IS THERE A PLUMBER IN THE HOUSE?

Sometimes you just have to plunge ahead. A California man learned this lesson when his sixty-five-year-old father suddenly collapsed in front of the family at his home. Poorly trained in cardiopulmonary resuscitation (CPR), the son unsuccessfully tried mouth-to-mouth breathing. Desperate, the son grabbed a toilet plunger and, according to the *Journal of the American Medical Association*, "proceeded to plunge his father's chest." The outcome: The patient was fully revived, but standard medical wisdom went down the drain.

"Perhaps the plunger effectively served as a chest compressor," speculates Dr. Keith Lurie, one of the cardiologists who later treated the patient at San Francisco General Hospital. "It's also possible that the suction between the chest wall and the plunger generated significant negative pressure that helped to ventilate the man."

Thrilled, the son later recommended coronary units be equipped with plungers. Says Dr. Lurie, "We recommend he take a basic course in CPR."

—Kathleen McAuliffe

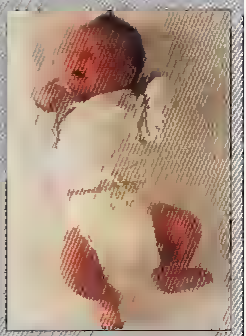
MOST HEART ATTACKS OCCUR BETWEEN 6:00 A.M. AND NOON, WHEN BLOOD PRESSURE NATURALLY RISES.

THE EGG STANDS ALONE

The field of birth control has just gotten a shot in the arm—literally.

Researchers at the University of Virginia have been experimenting with a vaccine that sparks a woman's immune system to develop antibodies to SP-10, a protein molecule that appears on the head of a sperm. During test-tube experiments, sperm attacked by the antibodies failed to penetrate an egg. The scientists are now testing the vaccine on baboons and may be ready for human tests in less than two years.

Ideally, the vaccine would last only a year or two. But researcher John Herr admits that the scientists "don't know yet whether it'll wear off or not."—Pat Janowski



A birth-control vaccine could be ready by the year 2000.

CONTINUUM

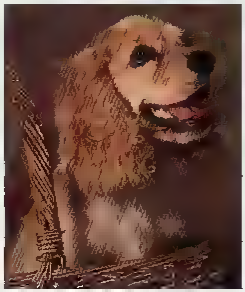
WHY DOGS BARK

A cocker spaniel, under observation, barked 907 times in ten minutes. Multiply that by 52 million, the number of dogs in the United States, and you have the potential for major noise. Hampshire College biologist Raymond Coppinger, who has spent 30 years studying dogs, teamed up with fellow linguist Mark Feinstein to figure out what's behind all that racket. Their conclusion: Dog barking is a pointless, energy-wasting activity.

"When dogs bark, they are doing the same kind of thing they do when they chase balls or their own tails," Coppinger and Feinstein report. "While these behaviors serve no real function, the dog is likely to repeat them over and over."

Barks can mean anything—let me in, let me out, feed me, pet me—or nothing at all. "Unlike other wild animal calls, the bark has no built-in biological meaning," Coppinger says. Newborn pups make whimpering, tonal sounds that do have an innate meaning. Take care of me. The snarls and growls of older dogs also convey a message. Get the hell out of here! The bark combines the tonal whines of a pup with the gnarly noises of an adult. The result is gobbledygook, Coppinger says. "It would be like a person saying, 'Comeheregoaway, comeheregoaway!'"

The explanation, he and Feinstein believe, lies in an evolutionary quirk that has left the domesticated dog in a state of permanent adolescence. Dogs bark for the same reason teenagers hang out in shopping malls. That's what adolescents do.—Steve Nadis



What do dogs and teenagers have in common?

BAR CODES BEHIND BARS

That'll be $2.39—er, exhibit no. 1.

Bar-code technology, long used by industry to track merchandise, is being used by law-enforcement officials as a weapon against paperwork.

In a growing number of states, including Florida, Maryland, and South Carolina, police officers use bar codes, widely seen on consumer goods, to keep track of evidence, register arrests, and process fines. Bar-code scanners also sit next to the gavel in some state courthouses. In Plymouth, Michigan, for example, courtrooms have adopted the technology in an effort to save time and cut down on administrative errors.

From K-mart to the courtroom: Law enforcement officers can save time and paperwork by using bar codes.

The Plymouth system, developed by Manatron Inc. in Kalamazoo, Michigan, will allow courtroom personnel to register all verdicts, adjournments, and prison sentences on a computer by waving a pen-shaped scanning wand over the appropriate codes—just like your friendly cashiers at the supermarket checkout line.

Nonetheless, it is not the intention of the Michigan court to treat a defendant like a piece of meat. Still, Judge James Garber says he hopes bar-code technology "is going to simplify things around here."—Bristol Lane Voss

CHILL OUT OR WARM UP?

Whether it's real or just the ravings of the scientific community, the so-called greenhouse effect has all the trappings of a Madison Avenue publicity campaign. Now a simple scientific principle could provide the evidence for or against the global warming theory.

Sound travels faster through warm water than it does through cold water. So scientists want to periodically measure the length of time it takes sound waves to travel undersea between two points. The results could tell the scientists if the ocean is getting warmer, University of Washington physicist Robert Spindel says.

In a preliminary test last January scientists lowered a transmitter into the water off Antarctica and sent sound waves to underwater listening posts in the United States, Australia, South Africa, India, and other countries. However, Spindel warns that it will take months of tests and data analysis before the technique is deemed accurate enough to gauge global warming. If the technique works, we should know after ten years of continuous observation whether the earth is warming up.—Steve Nadis

CONTINUUM

The Hubble telescope is getting a very pricey pair of glasses

COSTAR COMES THROUGH

In the movies most costars play second fiddle, but in the case of the Hubble Space Telescope (HST) a COSTAR may steal the show.

COSTAR (Corrective Optics Space Telescope Axial Replacement) is the leading contender in a number of plans to correct HST's faulty vision. Preliminary COSTAR designs call for the installation of a telephone-booth-size box, fitted with three pairs of postage-stamp-size mirrors to refocus the Wide Field/Planetary Camera, the optical device that was supposed to revolutionize astronomy. Dennis McCarthy, NASA's deputy program manager for the HST, says that COSTAR should greatly improve the telescope's image quality, bringing it closer to its original specifications.

A team of astronauts will spend about three days installing the corrective device, in addition to replacing the telescope's gyroscope and its solar arrays to correct the "bump" that disturbs the telescope as it passes between day and night. McCarthy estimates that the repair mission, slated for 1993, will cost between $20 million and $30 million. "The good news is that we *can* fix what's up there," McCarthy says. "The Hubble was designed to be repaired and maintained."

—Robert W. Tinsley

ENVIRONMENTAL MISTRIAL?

Polystyrene cups may have gotten a bum rap from environmentalists, according to chemist Martin Hocking at the University of Victoria in British Columbia. People who favor paper over polystyrene because of its biodegradability ignore the environmental impact of producing it. When Hocking looked at the energy consumed during the production of polystyrene cups versus paper cups, a very different picture emerged.

Compared to one polystyrene cup, the manufacture of a paper cup uses 6 times more steam, 24 times more electricity, and produces 200 times more wastewater. And although paper has the edge over polystyrene when it comes to degradation, Hocking cautions that the advantage may be moot. Paper buried in landfills in dry areas, for example, does not degrade any better than polystyrene. And paper that does break down in moist landfills produces gases that contribute to the greenhouse effect. "All things considered," says Hocking, "polystyrene foamware deserves an equivalent or better environmental rating than paper containers."

—Kathleen McAuliffe

LUNAR SUNBEAMS

The best way to get the sun's energy is via the moon, say two scientists.

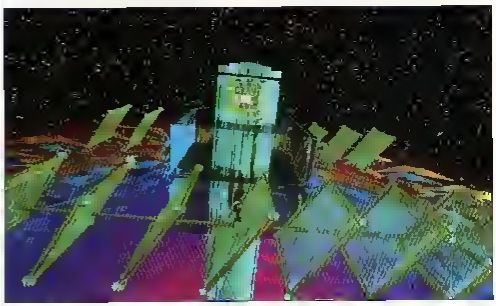
Photoelectric cells on the moon would convert sunlight first into electricity and then into microwaves, according to David Criswell, director of the Institute of Space Systems Operations at the University of Houston, and Robert Waldron of Rockwell International's Space Systems Division.

Between 10,000 and 100,000 reflectors placed in a circle would then beam the microwaves back to receiving antennas, called rectennas, on Earth.

Collecting solar power on the moon circumvents many of the problems of earthbound solar power. For example, "there is no weather or any clouds to get in the way," Criswell says. Plus, the sunlight-collecting equipment on the moon could be as thin and lightweight as paper because of the fact that the moon has no wind, rain, or even air to buffet it.

The microwave beams would be of very low intensity. "If you were standing on the beach in front of a rectenna, you would absorb much more energy from the sun than from the microwaves," Criswell adds.

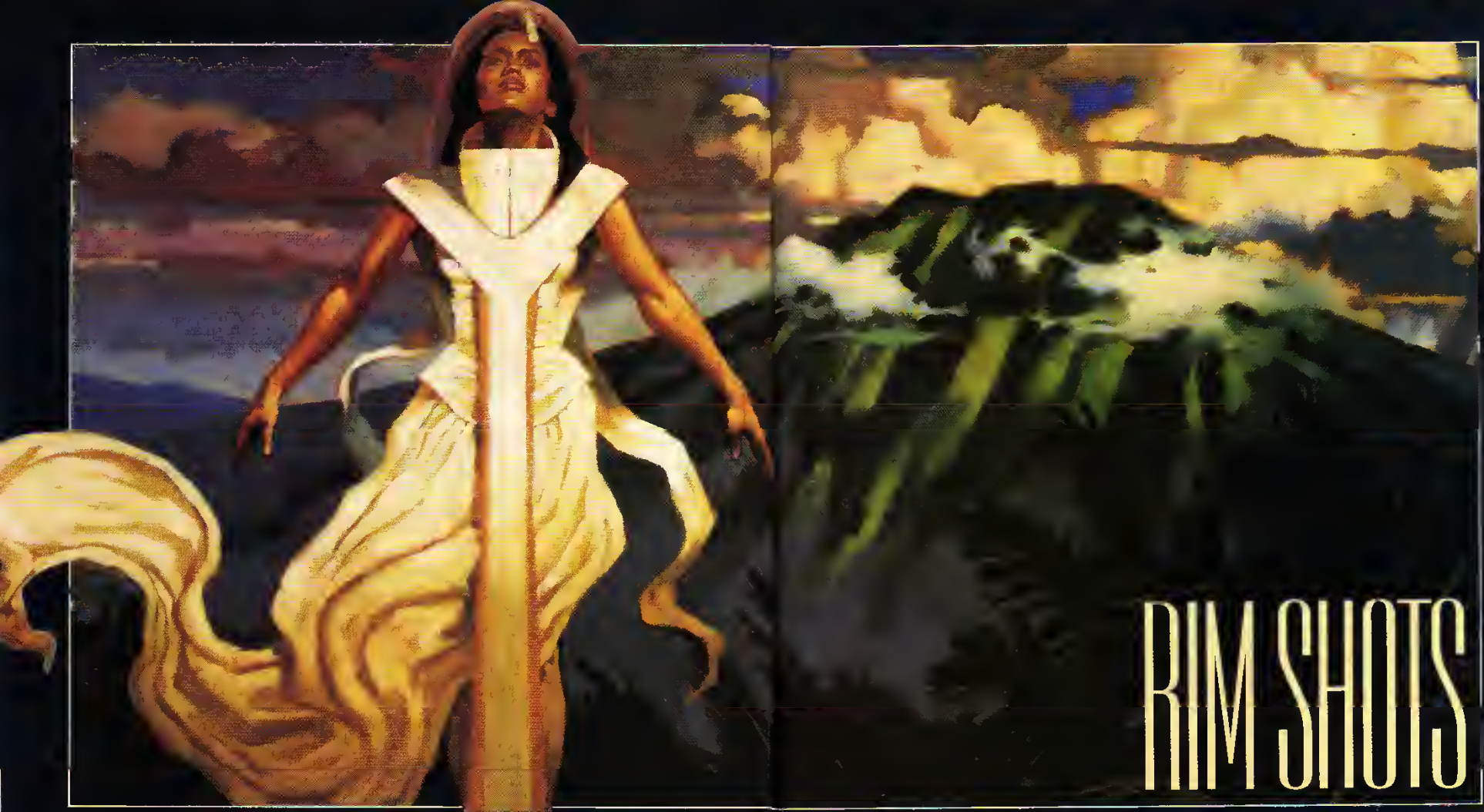
—Devera Pine



Sunshine from the moon: Photoelectric cells on the moon could supply plentiful, dependable solar power to the earth.

ALBERT EINSTEIN DIDN'T TALK UNTIL HE WAS FOUR YEARS OLD.

THE AVERAGE RAINDROP IS SAID TO CONTAIN 6,000,000,000,000,000,000,000 ATOMS.



RIM SHOTS

ARTICLE BY
TOM DWORETZKY

The Pacific could be the next gateway to the moon—and beyond

ILLUSTRATIONS BY
GREG MANCHESS

The biggest gun in the world sits braced against the mountainside of the 14,000-foot-high Mauna Loa volcano in Hawaii, its yard-wide barrel pointing toward the moon. This is no weapon of war, however. The projectile with which it is loaded contains food and other supplies for a bustling lunar base. At T minus zero, the launch director pushes a button, setting off the crack of an explosion. With a puff of billowing smoke and a burst of flame from the muzzle, the gun fires its payload with enough force to escape the ties of gravity and reach the moon. After the launch, workers move in, preparing the gun for the next shot. Setting up a rocket for liftoff would take days, weeks, or months. Readying the cannon will take about half an hour. It's so cheap and easy that the Pacific spaceport fires a dozen times each day.

In the near future this scene may be commonplace at a series of spaceports dotting the Pacific Rim. These new spaceports—and the novel vehicles that leave from them—will be owned and managed not by governments but by entrepreneurs. Without the red tape and bureaucracy that cripple agencies like NASA, say the entrepreneurs, a Pacific Rim effort will catapult space technology into a new, less expensive era of widespread access and use.

As costs plummet, first of all, a single mission will require thousands—not millions—of dollars to get off the ground. As a result, small businesses will take advantage of microgravity to study advanced chemical compounds. Tourists will enjoy the view of Spaceship Earth now available to only a select few. Orbiting and lunar-based hotels will house traveling salesmen, scientists, curious visitors, graduate students working on dissertations, and pilgrims seeking to settle a new frontier.

All this may sound far-fetched, but not to Bruce Roth. As the founder and president of a young

commercial space company Arizona-based Orbital Transport Services, he has spent the last decade trying to get ingenious projects like the Hawaiian space gun off the ground.

Roth is one of a number of iconoclasts who have argued with the space establishment for years. His claim: Only by developing next-generation spaceports and launch technologies can we continue our giant leap into space. Space-business consultant Jay Miller agrees. "The moon and Mars will remain beyond our reach," he says, "until these new low-cost systems are built."

The idea of launch sites in the Pacific Rim goes back decades. In 1961, for example, NASA itself considered Pacific sites for the Apollo program. In those heady, hectic days, when the agency was scrambling to meet President Kennedy's nine-year deadline to the moon, a NASA–Air Force team evaluated two such sites—one on Christmas Island and the other on the South Point on the island of Hawaii. The team found these sites viable but too costly because they were so remote. Cape Canaveral, already used by the Air Force to launch rockets, would cost only half as much to build and operate.

But times change. And by the early Eighties, Pacific Rim spaceports seemed like an idea whose time had come. The first impetus was the passage, in 1984, of the Commercial Space Launch Act. The new law called for the elimination of some of the red tape surrounding private sector space development and helped entrepreneurs get involved.

These entrepreneurs were further encouraged by a bold new market for the spaceports: the nations of the Pacific Rim. Japan, for instance, today has a vigorous fledgling space program, and Taiwan and Korea are talking about moving into the space business by the end of the decade.

The Chinese are already there, selling their own low-cost rockets and launch services at prices that can't be matched in the West. In fact, say the Chinese, they plan to launch a space station and a four-man capsule within the next 20 years.

Such ambitious plans indicate that these nations now view access to orbit as an economic necessity. Indeed, as growth potential flattens in electronics and automobiles, space will provide the new high-tech frontier. What's more, settling the high frontier is a potent sign of prestige. As John Pike, a space expert at the Federation of American Scientists, says, "One of the talismans of a first-rate country is a space program. It's like having a battleship before World War I."

But Pacific spaceports aren't just advantageous to nations of the Pacific Rim. No matter what country you're from, launching payloads from a tropical island may be the way to go. First of all, Pacific Rim sites are located

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SHOO SHOO BABY

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The B-17 "Flying Fortress" It was the very backbone of the Allied aerial offensive during World War II Now, to commemorate the 50th anniversary of World War II, the Air Force Museum Foundation authorizes the authentic re-creation of a rare surviving B-17G that actually saw combat It's called Shoo Shoo Baby, now on permanent display at the U.S Air Force Museum.

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near the equator, which puts your point of departure closer to equatorial orbit—the required orbit for satellites. Thus your vehicle takes advantage of the earth's high-speed rotation, more than 1,000 miles per hour at the equator, to catapult it into orbit, as a result, a given craft can lift more payload using the same amount of fuel. Even more advantageous, a number of islands have mountains. Taking off from a higher elevation allows a craft to avoid the thick lower atmosphere, where friction increases the amount of power needed to lift a payload to orbit.

And today the remoteness of these sites is also a plus for space travel. A big empty downrange area is important whenever something that goes up decides to come down—like a spent rocket stage. What falls from the sky shouldn't land on a populated area. It's also nice to be able to launch in almost any direction. At Cape Canaveral, for example, you can't fire a rocket over the populated heartland of the continental United States. This crucial restriction seriously limits the orbits into which you can easily place satellites.

Recognizing the value of a local spaceport, the state of Hawaii recently hired the Arthur D. Little firm to conduct a feasibility study. Little's analysts found that such a plan could succeed, and even suggested two sites for the enterprise: Palima and Kahilipali points, located along Highway 11 on the Big Island within 13 miles of each other at 19 degrees north latitude.

The Little experts also advised Hawaii to move ahead with an environmental impact statement (EIS) and master plan for the two locations. The state's EIS is now complete. And a federal Environmental Protection Agency statement should be finished in 1992. The master plan, meanwhile, proposes launch facilities for rockets ranging in size from small ones unable to reach orbit to large ones that can reach orbit with ease.

Yet another Pacific Rim spaceport is being considered at Cape York, Australia—a site that makes the Hawaii locations look like Times Square. According to Robert Gray, a former NASA launch director who has worked as a consultant to the Australian project, the Cape York site is particularly advantageous because it's located at about 12 degrees south latitude, very close to the equator. From this vantage point, Gray says, "it will allow you to launch about fifteen to twenty percent more payload than Canaveral, and about thirty to forty percent more payload than you could from the Soviets' Baikonur.

In order to interest investors in funding Pacific Rim spaceports, however, advocates must come up with novel new rockets—ones that are drastically cheaper to build and use than the conventional rockets of today. Plans for alternatives to today's expendable rockets—which are essentially discarded after a single use—have been around for decades. In the Fifties, for example, the late Gerald Bull, a Canadian artillery genius, worked furiously to make a gun able to shoot a payload to space—a joint U.S.–Canadian effort known as HARP (High Altitude Research Project). Bull actually built an enormous space gun in Barbados, one that was almost able to launch a projectile into orbit. Unfortunately, he ran into pressure from rocket makers, who viewed his efforts as a threat to their control over access to space.

The gun launcher concept lay dormant until Roth grew interested. Sitting in his neat two-story house across from the public library in suburban Glendale, Arizona, the ex-Marine and Vietnam veteran and father of two and a half (his physician wife is pregnant with number three) explains that he had the good fortune to rediscover HARP about two years ago. That was when he came across a book about it written by Bull and Charles Murphy of the Ballistics Research Laboratory at the Aberdeen Proving Grounds.

"I spoke with Bull at that time," he recalls. Unfortunately, this potential collaboration was cut short. By the late Eighties, Bull, based in Brussels, was hard at work on a superweapon capable of raining down poison gas, high explosives, and even nuclear weapons for President Saddam Hussein. In 1990 he was found shot dead.

Even without Bull, however, the creation of a space gun is in the cards. As a first step, Roth says, he would like to design a gun that could "lift experiments in trajectories just shy of orbit." The suggested location: atop a barge based in Pearl Harbor. "The whole project wouldn't cost more than about two million dollars. That way I could prove the viability of an alternative launch technology and the value of Pacific launchings at a price that would be downright cheap compared to the average rocket." Eventually, he adds, he envisions building a gun big enough to boost payloads to orbit from Mauna Loa.

Other reusable launch designs are in the works. Thanks to funding from the Strategic Defense Initiative Organization (SDIO), four aerospace companies—General Dynamics, McDonnell Douglas, Rockwell, and Boeing—have designed prototypes of reusable rockets. Some of these take off and land horizontally, like airplanes. Others lift off vertically and land horizontally, like the space shuttle. Yet others take off vertically, like a rocket, and touch down vertically, like an Apollo-style moon lander. Plans call for all to weigh about 1 million pounds fully loaded and lift a 10,000-pound payload to orbit.

"I think the best technical and economic choice will prove to be a vehicle that lifts off like a rocket and lands bottom first," says space consultant Gary Hudson, who has advised both General Dynamics and Boeing on their reusable launch designs.

Finally, if Roth has his way, Pacific Rim spaceports will be home to the electromagnetic launcher (EML). Designed to operate at sites like the rim of Hawaii's Mauna Kea volcano, the EML makes use of technology similar to that found in the magnetic levitation (mag-lev) trains now under development in Europe and Japan. The EML is basically a long tube with magnets embedded in its walls. The projectile that is loaded into this tube also contains magnets. When opposite charges are applied to both magnets embedded in the wall and magnets embedded in the projectile, the force of repulsion ejects the projectile at more than 25,000 miles per hour—the velocity needed to escape Earth's gravitational pull.

Before such visionary technologies as the EML can be launched from spaceports of the Pacific Rim, however, there are important hurdles to overcome. Chief among them may well be the aerospace subculture itself. The problem, according to University of Arizona professor Andrew Cutler, "We don't have a space program, we have a jobs program."

Instead of supporting the private space sector by reducing regulation and offering financial and tax incentives, the government has maintained control over access to orbit. To do this, Cutler strongly maintains, it has been necessary for NASA and the U.S. aerospace industry to maintain a fiction that the country has all the launch capacity it needs. But if you think that's true, consider how long payloads are delayed before launch.

In 1981, for example, there was a real slaughter of the innocents when NASA terminated two thirds of the payloads supposed to be launched on the shuttle. Some of the space programs axed to support this myth include the lunar polar orbiter, which should have gone every year since 1972 but hasn't gone once; the Mars Observer, put off five times and finally set for a 1993 launch date; and the now notorious Hubble Space Telescope, which sat around for nearly a decade before finally hitching a ride.

"If you look at government statistics," says Cutler, "they will always show an excess launch capacity. But if you look at how long the average payload must wait to get launched, capacity could be increased by a factor of five and still be utilized."

Despite this fact, it is extremely difficult to launch an American satellite on a cheap Soviet rocket. The federal government, with the support of the U.S. aerospace industry and NASA, has prevented this, claiming that there is a risk of giving away technological secrets to the Soviet Union.

But experts like Cutler don't believe that high security is the true agenda at all. Instead, they contend, the restrictive measures are in place to protect U.S. rocket makers from less expensive foreign manufacturers. The restrictions also hinder technologically savvy nations like Japan and Korea from threatening the dominance of the U.S. aerospace industry as they have with electronics in the past.

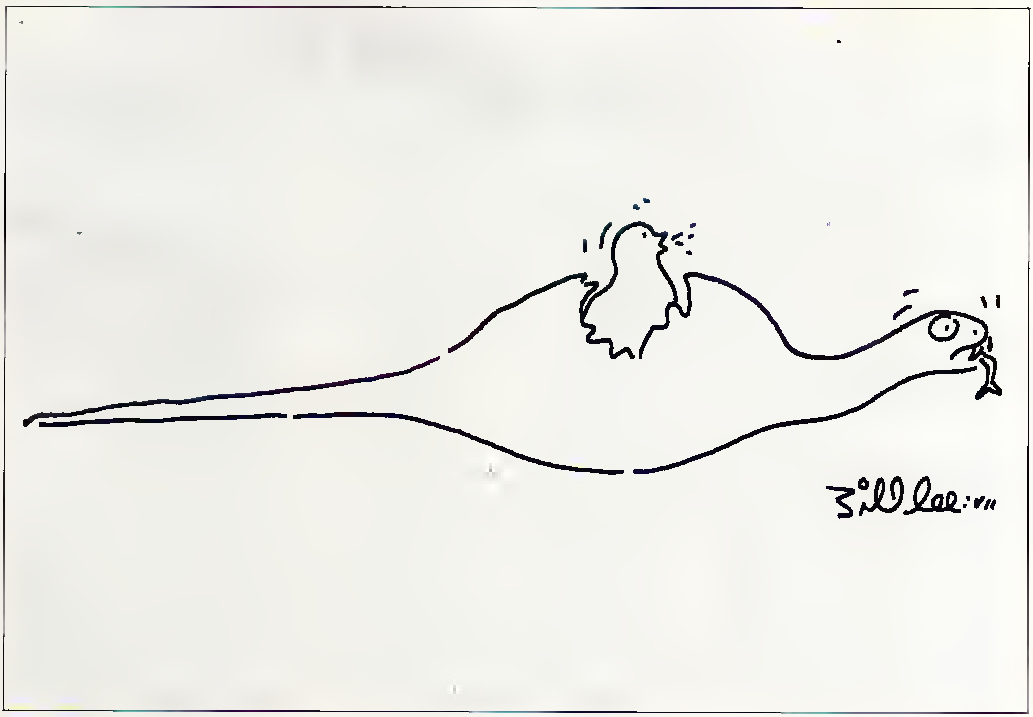
Should American restrictions prevail, Pacific Rim space proponents see real trouble ahead for space development. First of all, they say, investors will be reluctant to put financial muscle behind facilities like those proposed for Hawaii and Cape York.

And ultimately U.S. restrictions will hurt the American aerospace industry most of all. "A nation that restricts the overall services its companies can provide—as we now do—will ultimately do those companies more harm than good," Cutler says. "In the end, nobody will buy from those companies." In other words, if our satellite makers can launch only on overpriced American rockets, they will eventually be driven bankrupt by serious competition from foreign satellite makers able to grab cheaper rides.

"If we stick to this strategy, our satellite and launcher companies will sell their goods for the next few years," says Cutler. "But soon, with or without our nation's blessing, financing from the rest of the world will pay for a Pacific spaceport dedicated to international and commercial space."

These spaceports will, of course, use the next generation of technology to offer unbeatable prices to the high frontier. "If the U.S. space program is controlled and protected from international competition and the impacts of new technologies," adds Cutler, "then the American space industry will be dead." There is an alternative, however. "Admit that the free market is going to work in space," he says, "the same as it does everywhere else."

Once the space game becomes the realm of the entrepreneur, the movement to the high frontier will proceed. Soviet payloads launched from Pacific Rim spaceports will stock the larders of Swedish hotels in orbit. Settlers from every nation will lift off—at relatively little cost—to establish colonies on the moon and Mars. And orbiting factories, their emissions no longer a threat to the fragile biosphere of Earth, will manufacture everything from medicines to exotic new construction materials in the weightlessness of space. Once we have gained free and easy access to orbit, the Pacific Rim may become the hub not just of our world, but of countless worlds to come. ∞



ARTICLE

SPACEWARD HO!

BY BEN BOVA AND STEPHEN L. GILLETT

Settling the final frontier:
Can government and private enterprise work together?

ILLUSTRATION BY BRALDT BRALDS

What is the best way to develop the space frontier? The quickest, least costly way to build space stations and lunar habitats to explore the solar system and utilize its resources for the benefit of humankind?

A growing number of space enthusiasts are insisting that the best way is to get the government out of space altogether. Step aside, NASA, they say. Let private enterprise do the job!

Their argument is that no government agency has ever done anything on time or within budget. Okay, maybe NASA did get us to the moon. But nowadays the agency is old and weary and always in trouble with Congress. Now is the time to let private industry exploit the new frontier of space. If there's truly gold in them there hills, the profit motive will get us to it long before any government bureaucracy can.

Too bad there's no historical justification for this view. The government has *always* been at the frontier of pioneering development, in areas from building canals to railroads to the airplane industry.

Private enterprise has been conspicuously absent from space until very recently. Thirty-two years elapsed between the 1957 debut flight of the original *Sputnik* satellite by the Soviet Union and the first launch of a satellite by a private firm, in 1989.

Admittedly, private communications companies jumped into the communications satellite business with some fervor in the Sixties. But comsats were proven technology with a ready market. And until recently they were all launched by government boosters.

The kinds of people who have the assets it takes to do business in space simply do not invest huge sums upfront unless they see a quick return. You don't make money by sinking an extremely large amount of capital into a high-risk operation that won't pay off for years, if at all. Space development makes oil exploration—traditionally a high-risk endeavor—look tame.

The risk is incalculable. Questions about the possibility of developing products in space are still largely unanswerable. How big will the market be for new plastics or crystals grown in zero gravity? What kinds of profits can an investor expect from space-manufactured pharmaceuticals? Can anyone make money from basic research in space? From oxygen manufactured on the moon? From high-grade ores mined in the asteroids? Not in this fiscal quarter!

People involved with business must be conservative because most new ideas don't make profits right away. Still, the United States has led the world in pioneering developments for the past century or more—and has done so by effectively combining the efforts of both private industry and the federal government.

Take, for example, the transcontinental railroad. Visionaries started proposing a railroad to the Pacific as early as the 1840's, when railroads were little more than dangerous toys. Such dreams prompted the famous Daniel Webster to complain on the floor of the U.S. Senate:

> What do we want of this vast, worthless area? To what use could we ever hope to put these great deserts or these great mountain ranges? . . . What can we ever hope to do with a distant Western coast, a coast of three thousand miles, rock-bound, cheerless, and uninviting? . . . "

Today you can frequently overhear similar complaints about the "worthlessness" of space.

Private companies could not begin to raise the capital needed to build a coast to coast railroad without some form of government guarantee. The federal government had subsidized earlier transportation projects such as canals, turnpikes, and harbors, usually by giving land grants to investing companies. By 1850 Congress had granted millions of acres from the public domain.

Congress finally passed the Pacific Railroad Act in 1862, largely because of the Civil War. Lincoln feared that far-away California might also secede without some form of Union commitment.

The act set up a system of federal loans, repayable over 30 years, to fund the expansion. It also granted land from the public domain along the right-of-way. By 1871 more than 130 million additional acres had been given to the railroads. This was a painless subsidy, which did not involve spending taxpayers' money.

With hindsight it is easy to make fun of the shortsightedness of the railroad's opponents. But the vast risks of the project should not be forgotten. Like the Apollo project, it truly was a pioneering effort, and it was far from easy. When Webster made his comment he was merely expressing the wisdom shared by many Americans.

To develop the space frontier we need far more than just a transportation system. An entire infrastructure of shelters, living quarters, and supplies must be built in space, just as forts, towns, farms, and mines slowly civilized the Western frontier.

A better analogy to space development would be a situation where a mas-

sive infrastructure had to be built before any significant settlement could even begin. Such historical examples exist: the great water and power projects of the West, which allowed people to live and prosper in areas that had originally been arid wilderness.

Beyond the 100th parallel (west of Dodge City, Kansas) most land is too dry to farm with rainfall alone. By the turn of the century larger, more capital-intensive irrigation projects became trendy speculative ventures of private investors. Undercapitalized and unable to maintain cash flow, most were fated to collapse miserably.

Large irrigation projects also ran into major legal tangles, especially over navigation rights. Irrigation dams ruined a river's utility as a transportation artery and most of the rivers useful for irrigation dams crossed state boundaries. The federal government was the only agency that could step in and sort out such situations.

Another thorny issue: generating and selling electrical power. The agriculture made possible by irrigation was insufficiently profitable to pay for the massive projects. Electricity held the promise of payback, but would the government generate electricity in competition with the private sector?

This tangle of conflicts led to the establishment in 1902 of the Reclamation Service, later renamed the Bureau of Reclamation. Thus, by the turn of the century, a federal agency had been created to build and pay for the massive infrastructure needed to irrigate and power the dry Western lands.

One of the first projects launched was on the Salt River in central Arizona, an undertaking that eventually turned Phoenix into a major metropolis. Tentative private irrigation ventures along the Salt River had foundered in the late 1880's along with the hopeful landowners' money. Annoyed landowners called for a comprehensive project that would subsume these piecemeal efforts. Too many small irrigation projects conflicted with one another, and the massive structures required to harness the river system were beyond the reach of any one company.

The Salt River project began in 1903. Its heart was Roosevelt Dam, the first dam to generate hydroelectric power to help pay for its construction. The sheer scale of the dam, still the largest stone masonry dam in the world, required innovations in design and logistics comparable to the advances demanded by the space shuttle. And like the space shuttle, delays and cost overruns constantly plagued the project. Engineers had underestimated the problems to be solved, and landowners had overestimated the immediate profits from the irrigation.

Such problems are not surprising in retrospect. They were aggravated however by unrealistic expectations. An incongruous Utopian flavor pervaded these early irrigation projects. They were intended as social experiments as much as technical projects.

Many well-educated people thought that the "scientific" management of such a major project by government experts would eventually show the way to the perfect society—a spinoff from the Progressive movement of the time. Echoes of such sentiments arose when visionaries such as Gerard O'Neill first proposed L-5 space colonies in the early Seventies.

The Salt River project was successful mainly because it was run, for the most part, by local landowners who were already experienced in the difficult and complex art of irrigation. When the irrigation works were turned over to the landowners' irrigation district in 1917, they proved quite capable of managing the project themselves, without government experts and without pov-

CONTINUED ON PAGE 63

"His specialty is motivation."

THE OMNI OVERVIEW

Is Earth's complex climate machine on the blink—or is it just having a bad century?

THE GREENHOUSE EFFECT: APOCALYPSE NOW OR CHICKEN LITTLE?

BY ROBERT SILVERBERG

The world's temperature has been rising lately, just as apocalypse-minded "greenhouse effect" scientists have predicted. And there's no doubt that the levels of carbon dioxide, methane, and other heat-retaining "greenhouse gases" in our atmosphere are also climbing. We seem to be well along our way toward the torrid, sultry, terrifying future that the climatologists say is coming—a world of melting polar ice caps, drowned coastal cities, and vast migrations as new patterns of drought and heat make great sections of the globe uninhabitable.

Or are we? Some scientists are not so sure that the recent doomsday scenarios ought to be taken so readily at face value. They call for cautious examination of the whole greenhouse concept before we plunge into any sort of crash program for purifying our atmosphere—a program that the congressional Office of Technology Assessment estimates could cost as much as $150 billion a year over the next 25 years simply to reduce carbon dioxide emissions to about 65 percent of today's levels.

While the scientists bicker,

PAINTINGS BY DOUG WEBB

what's the public to make of the baffling mass of seemingly conflicting data on global warming? History provides few clues; our climate records have proved an imperfect tool for prediction at best. It's enough to tempt even the most scientifically savvy among us to dismiss the issue altogether.

But that's just what we cannot afford to do. Crisis or not, it's time for a rational approach to unveiling the mysteries of the global climate machine. Whether the greenhouse effect foreshadows a cataclysmic event or a mere blip on the climatic time line, the current debate deserves close attention.

The greenhouse-effect theory of climate is nothing new. The concept dates back to 1822, when the French mathematician Jean Fourier likened the earth's atmosphere to the glass walls of a plant conservatory. A greenhouse's walls allow solar energy to enter, then trap its component of heat by blocking the outward radiation of infrared waves. Later in the nineteenth century scientists discovered that the heat-trapping component of our atmosphere is carbon dioxide (CO_2), and in 1897 the Swedish chemist S. A. Arrhenius, studying the relationship between global temperatures and the quantity of CO_2 in the atmosphere, calculated that a doubling of the present amount of atmospheric CO_2 would produce a mean global warming of 4° to 6°C or 7° to 11°F—with accompanying catastrophic environmental changes.

WHAT ARE WE TO MAKE OF THE MASS OF CONFLICTING DATA? THE CURRENT DEBATE WARRANTS OUR ATTENTION AND STUDY.

The amount of CO_2 in the atmosphere is minute: a little more than 300 parts per million, or one thirtieth of one percent. But that percentage has been growing rapidly in the century since Arrhenius. Vast quantities of CO_2 were locked up long ago in the "fossil fuels"—coal, oil, natural gas—that were created by the decay of organic matter at a time when the earth's climate was much warmer than it is today. We are now busily unlocking that treasure house of energy and our rate of consumption is rising from year to year, with the liberation of CO_2 rising in proportion as well.

Between 1860 and 1959 the combustion of coal and other fossil fuels released an amount of CO_2 equal to 14 percent of the total already in the atmosphere. Some of this was absorbed by the oceans, the rest remained in the air. By 1960 the quantity of atmospheric CO_2 was about 7 percent greater than it had been in the middle of the nineteenth century.

But that was only the beginning. Between 1958 and 1962 alone, the CO_2 content of the atmosphere grew by 1.15 percent. In those five years, the burning of fossil fuels released 53 billion tons of CO_2, and 26 billion tons of that accumulated in the atmosphere. And the CO_2 level has risen in each year since. In the past 30 years it has gone from 315 parts per million to 355, an increase of more than 20 percent in the past century and more than 10 percent in a single generation.

Nor is CO_2 the only gas that produces the greenhouse effect. Methane (CH_4), which is released by decaying matter in marshes and tundra, the actions of termites, and cattle breaking wind, has some 20 times the heat-trapping quality of CO_2. Methane is increasing in our atmosphere at a rate of about 1 percent a year. So, too, are the various nitrogen oxides thrown off by factory smokestacks, automobile exhausts, and the breakdown of agricultural fertilizers. Then there are the sinister chlorofluorocarbons (CFCs) emitted by refrigerators, air conditioners, aerosol devices, and other products of twentieth-century ingenuity. Neither methane nor nitrogen oxide nor CFCs played any part in Arrhenius's original greenhouse-effect calculations.

With all four kinds of greenhouse gases piling up in the atmosphere at a rate unprecedented in the planet's history, then we must be right on course for the catastrophic warming that the Arrhenius data indicate. A rise of 7° to 11°F in the mean global temperature may not sound like very much. But in fact just such a drop, some 25,000 years ago, sent glaciers down across Europe and North America and plunged the world into an ice age lasting thousands of years. An increase of little more than that magnitude 200 million years ago created the muggy, swampy tropical world in which the dinosaurs flourished.

If a temperature increase of the Arrhenius magnitude were to happen now, floods caused by the melting of the polar ice caps would submerge thousands of miles of low-lying coastline within a matter of 40 or 50 years. The rising oceans would cover all of Florida south of Lake Okeechobee, and Washington, DC, would be covered almost to the White House and the Capitol steps. Low-lying islands throughout the world would disappear. Rainfall patterns would shift, turning the grain-belt districts in the interiors of our continents into dust bowls and bringing devastating torrential deluges elsewhere. Some rivers would become virtually dry, others would rise to the point of becoming unnavigable. Millions would starve. The climate crisis would disrupt the living habits of entire nations. No wonder that Roger Revelle and Hans Suess of the Scripps Institution of Oceanography, contemplating the steady increase in atmospheric CO_2 levels, declared as far back as 1957 that humanity is performing a "great geophysical experiment"—with the entire planet as its lab.

And all the evidence indicates that the globe is warming just as the theory predicts. 1987 and 1988 were the two warmest years since reliable record-keeping began in the late nineteenth century, and the summer of 1988 saw not only scorching temperatures almost everywhere but a horrendous drought in most agricultural regions. "We can state with ninety nine percent confidence," James Hansen of NASA's Goddard Institute told the U.S. Senate during testimony that fierce summer, "that current temperatures represent a real global warming trend, rather than a chance fluctuation. We will surely have many more years like this—more droughts and many more days above a hundred degrees [F]—in the Nineties." Indeed the average temperature for 1989 was warmer than that of record-breaking 1988, and 1990 was hotter still, coming in with a mean global temperature of just under 60°F.

Hansen's dire warnings set off a political uproar. Environmental-minded legislators called for immediate cutbacks in fossil fuel usage, changes in agricultural practices, restrictions on CFCs beyond those already agreed to for minimizing ozone layer damage, a halt to the destruction of the world's forests, a worldwide treaty covering atmospheric pollution, and a host of other drastic corrective measures. World leaders issued statements and urged action. Petitions were signed, placards were waved, considerable panic was generated among ordinary citizens.

But very little of a substantive nature has been done so far to ward off the coming environmental catastrophe. Mainly, two big conferences have been held in Washington, DC, one in April 1990 and a second in February 1991 at which scientists and government officials from 130 nations got together to discuss the problem of global warming. What came out of both conferences were the expectable expressions of deep concern—an 'action agenda' but no real action—and resolutions calling for continued study, plus plans for four more conferences, culminating with a June 1992 conference in Rio de Janeiro at which representatives would sign an international treaty.

Meanwhile, greenhouse gases continue to pour into the atmosphere every day. But while environmentalists, their dismay growing hour by hour, continue to call for strict and immediate regulatory action, climatologists argue over whether there is a crisis at all. The austere pages of *Science*, the nation's foremost scientific journal, have rung with accusations that the advocates of a crash antigreenhouse program are practicing "junk science" and "science by consensus." The more conservative scientists claim that their apocalyptic-minded colleagues have succumbed to a Chicken Little syndrome, crying out that the sky is falling when in fact nothing of the sort seems to be taking place. They say that what greenhouse alarmists are doing is sorting through the evidence looking for data that will advance their own research agendas.

"There is a selective use of facts," said S. Fred Singer, an atmospheric and space physicist with the Washington Institute, at the global-warming conference last winter. "Nobody tells an untruth, but nobody tells the whole truth, either. It all depends on the ideological outlook. . . . My nuclear friends are happy to promote the greenhouse effect. My natural gas friends are happy to promote the greenhouse effect. A lot of scientists promote the greenhouse effect because of increased funding." *Forbes* magazine ran a cover story entitled "The Global Warming Panic: A Classic Case of Overreaction."

What's going on? Are we doomed or aren't we?

There are three points to bear in mind as we contemplate the possibility of a world transformed by rising temperatures:

- Changes in greenhouse-gas levels aren't the only factor involved in worldwide temperature fluctuations.
- Feedback processes that we barely understand today may serve to counteract the worst of the greenhouse-effect problems caused by rising atmospheric gas content.

• Warmer global temperatures don t nec essarily spell doom especially if upward changes furn out to be less severe than some climatologists predicted

Scientists moreover need to place the unquestionable statistics on global warming in the Eighties in a larger his torical context The world indeed saw a general pattern of warming temperatures around 1890 just as the modern era of industrial expansion was hitting its first great peak and greenhouse gas emissions began to climb A steady pat tern of rising temperatures was record ed over the succeeding decades

But the rate of temperature increase between 1920 and 1940 exceeded the level that could be accounted for by greenhouse effect calculations alone And then in 1940 global temperatures began to turn *cooler* again—precisely at the time when World War II was spurring another tremendous expansion in industrial activity For the nexf thirty years, *as atmospheric pollution increased year by year* mean world temperatures dropped steadily The winter of 1962–63 for instance brought England its coldesf winter since 1740, averaging 32°F for three consecutive months Not until 1970 did temperatures start climbing again a rise fhat so far has gone on unchecked

Climatological history reveals all manner of sharp temperature fluctuations during eras-utterly unaffected by human environmental meddling The ice ages fhaf periodically afflict this planef are the most spectacular examples The temperature increase during the era of the dinosaurs constitutes another Prehistoric shifts in rainfall distribution stimulated the development of extraordinary human cultures in prehistoric Egypt and Mesopotamia and wiped out one in the Sahara More recently, a period of climate cooling lasting from the fifteenth fo the eighfeenth century brought a "fittle ice age" to preindustrial Europe that killed the rich vineyards of England and destroyed the colonies that the Norsemen had planted in Greenland. In Queen Elizabeth's time people skated on the frozen Thames in winter By 1800 the climate was furning warmer again; the Thames has not frozen over since 1814 And so it has gone, up and down, through all the billions of years of our planet s existence

Many forces affect Earth s climate, not all of which we undersfand The chief climatic factor is fhe energy we receive from the sun But the amount of solar radiation we get is not necessarily consistent throughout time. The sun has undergone many changes in size and radiative power in the last few billion years Its output seems to vary, furthermore in relation to fhe 11-year sunspot cycle—the low-temperafure points of the "little ice age" period in medieval and Renaissance Europe coincided with prolonged periods of low sunspot activity recorded in 1280–1350, 1450–1550, and 1645–1715 Larger changes in solar activity the result of forces we don't really comprehend (and certainly could never hope to control), may correlate with the severe glacial periods in the remote past and with periods of above-average warmth during the icy interludes

Volcanic activity moreover can produce cooling phases The gianf eruption of Krakatoa, near Java in 1883, spewed 13 cubic miles of debris into the air and reduced the sunlight falling on distant European observatories from 10 to 20 percent for the following three years Other great eruptions in 1902 (in the West Indies) and 1912 (in Alaska) had the same effect An almost total absence of major volcanic blasfs between 1920 and 1940 may have been responsible for the period of unusually rapid warming that was recorded then, rather than the increase in atmospheric greenhouse-gas levels that was going on af the same time We just don t know

Changes in the earth s position relative to the sun movements of the earth along its own axis, and the migration of the continents over long periods of time, must all be considered possible causes of the great temperature shifts that are evident in the geological and fossil records Against such immense geophysical upheavals, a rise in the level of greenhouse gases may turn out to be a very small factor indeed

Then too we have no assurance that the undeniable increase in atmospheric CO_2 and the other greenhouse gases will have the predicted severe consequences Large-scale feedback processes may profecf us against the folly of our own pollutions

Atmospheric CO_2 for example, stimulates planf growth Plants absorb CO_2 in fhe course of the process of photosynfhesis The more plants there are the more CO_2 they will take in, thereby helping to reduce the atmospheric oversupply This is *negative feedback*—a self-correcting mechanism in which a problem generafes its own solution

Another kind of negative feedback that may ease our greenhouse problem Clouds reflect sunlight back to space, thus cooling the climate Increased ocean evaporation caused by rising temperatures may enhance cloud cover

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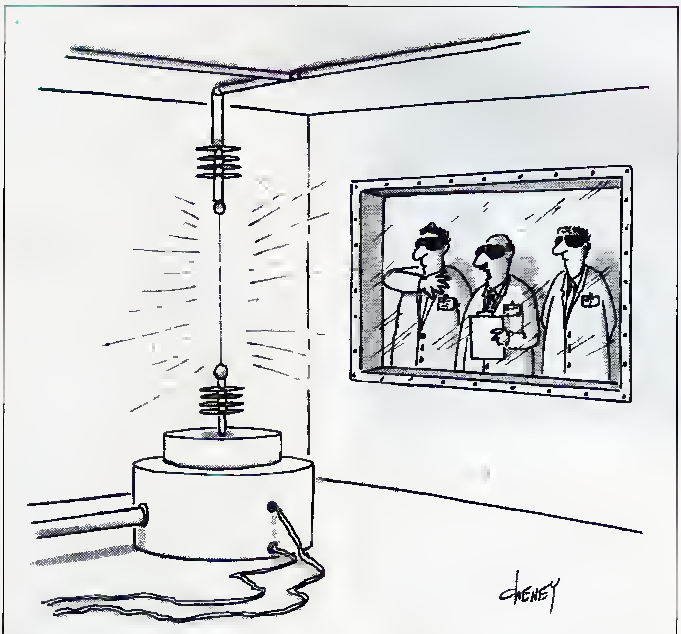
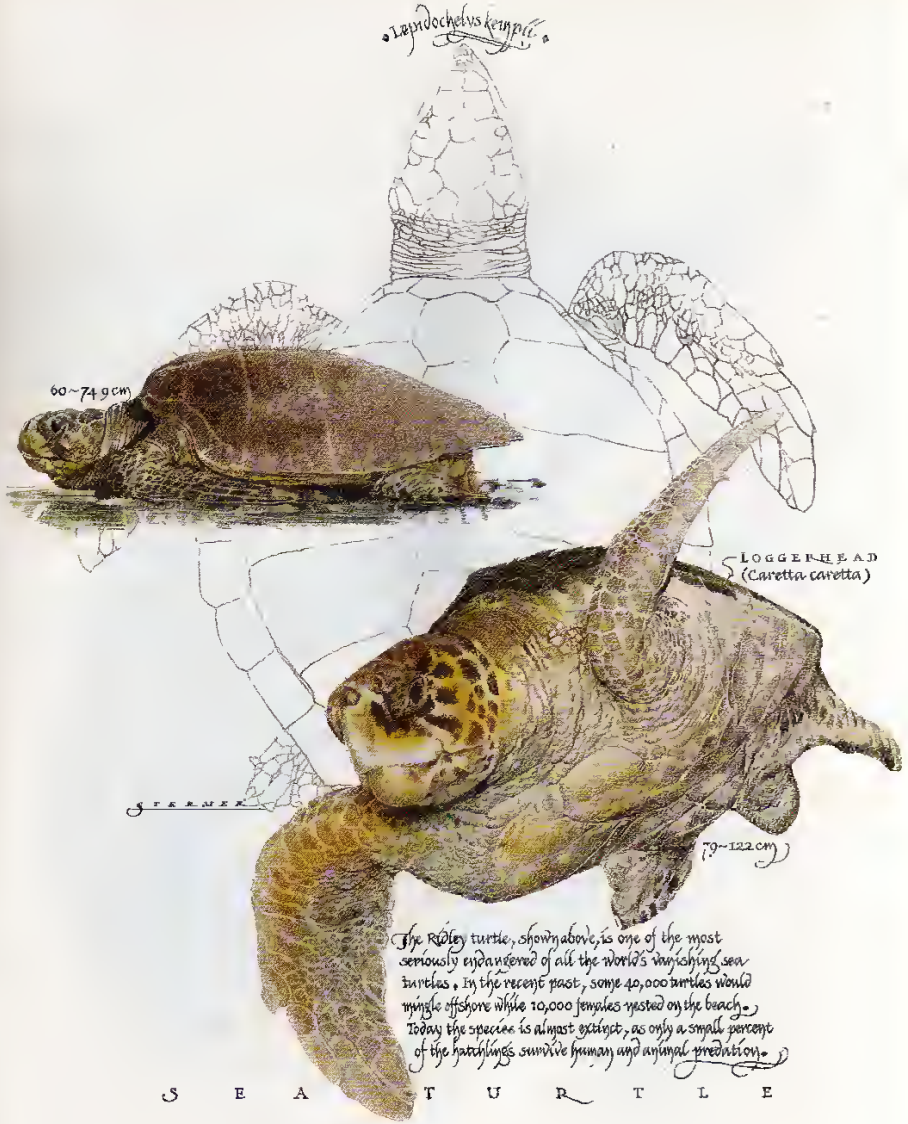


"There you have it, gentlemen—the fine line between genuine religious conviction and trendy moral posturing."

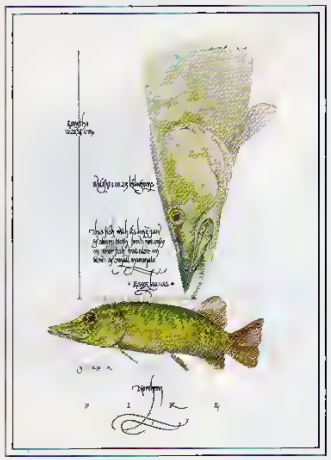
DUGALD STERMER: ILLUSTRATOR OF THE LOST ARK

Text by Sandy Fritz

As marble beckons the sculptor to unlock its masterpiece, so Dugald Stermer's subjects call to him. "It almost feels like sculpture," says Stermer of his drawings. "It's like that old statement: You take a block of marble and you carve away anything that isn't David." Each month Stermer "sculpts" a new drawing for the Japanese magazine *Gulliver,* selections from which appear on the following pages. "I knew we were in for a real ride," Stermer thought when he first received the assignment two years ago. "They wanted a section called Noah's Ark. But it wasn't the traditional giraffe or lion they wanted. In fact, few of the subjects have been in step with the traditional Noah's Ark image." Despite his atypical subjects, Stermer draws inspiration from such naturalist-illustrators as Alexander Wilson, Edward Lear, and John James Audubon, artists who established the style and tone of nature illustration during the early part of the nineteenth century. Stermer's work not only echoes the tradition but also includes criteria that might seem alien to these pioneers. "When the drawing begins to have a life of its own, and when it conveys what you want it to convey, that's when I leave it alone," Stermer says. "I'm learning to leave things out. I'm



"When the drawing begins to have a life of its own, that's when I leave it alone."

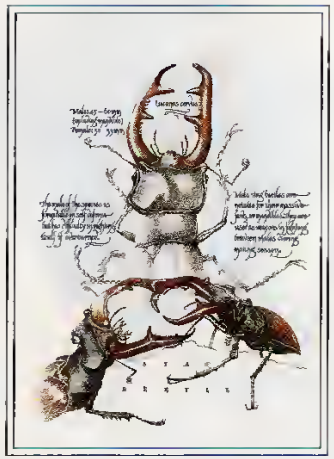


learning when to push my chair away from the drawing board."

The San Francisco-based artist has also learned to employ a device not available to earlier nature illustrators—the camera. "The camera is a powerful tool," Stermer says. "To draw without using photography as a reference seems, to me, really silly. Some illustrators deny using it. But I have to see things very clearly. I always need to see the specifics."

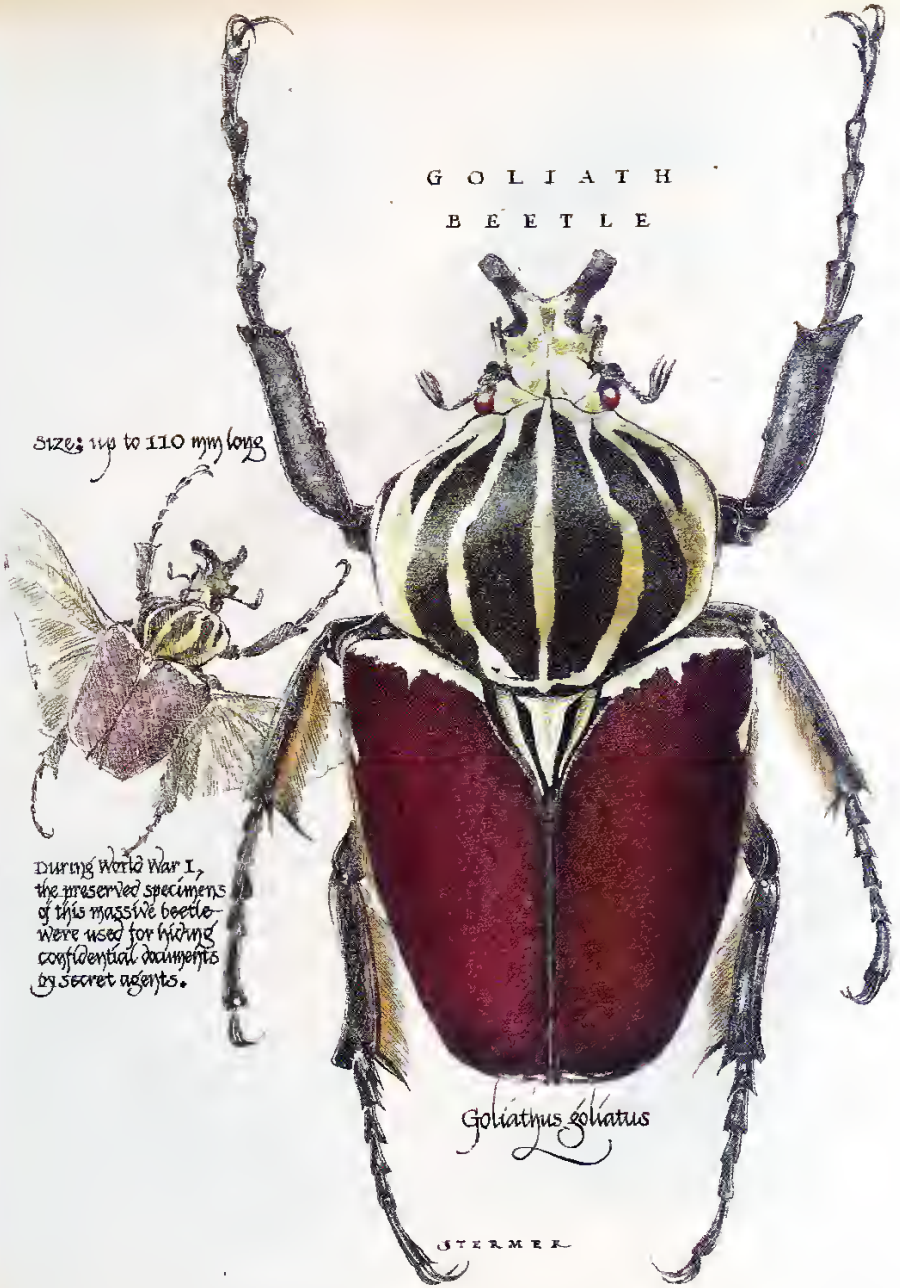
To judge by the delicate watercolor hues and the clear, crisp lines that frame his subjects, Stermer's techniques hit their mark. "My work is quick," he says. "I don't labor over the stuff. In fact, the more I labor, the

I don't labor over the stuff. In fact, the more I labor, the less good it is."



less good it is. These pieces take a day, a day and a half, from start to finish. I don't have to worry to death."

The speed with which Stermer works can be misleading. The artist has spent years "sharpening my pencil to a finer point, looking closer, building observation skills, and strengthening my focus." He takes joy in both the act of creation and its final product. "I'm very grateful to see my craft improving," he says. "Not many people fifty years old or so are conscious of their craft improving daily, but it's one of my major goals. My work is not on the cutting edge of illustration by any means, but I'm never bored," Stermer says ∞



The pioneer who conducted the first human gene therapy is looking toward gene transfer to treat diabetes and heart disease and maybe even double life span. In a thousand years, he adds, you may *have* to augment your DNA

INTERVIEW

W. FRENCH ANDERSON

He always knew what he wanted to do. In the late Fifties, before recombinant DNA technology was drawing board theory, he vowed to cure hereditary disorders by repairing faulty genes. His Harvard professors laughed at the aspiring genetic surgeon with the Okie accent and cowboy boots. But W. French Anderson, now chief of the Molecular Hematology Branch at the National Heart, Lung, Blood Institute in Bethesda, Maryland, never wavered in his mission to bring gene therapy from the laboratory bench to the patient's bedside. And in September 1990, Anderson and his colleagues ushered in a new era of medicine with the first human gene procedure aimed at correcting a hereditary disease.

The patient, a four-year-old girl, was born with an adenosine deaminase (ADA) deficiency. She lacked the same key immune cell enzyme as David the bubble boy, whose defenses were so im-

PHOTOGRAPHS BY JOHN STUART

NAME:
W. French Anderson

AGE:
Fifty-four

HOMETOWN:
Tulsa, Oklahoma

DEGREES:
M.D. (pediatrics), black belt Tae Kwon Do (fourth-degree)

OCCUPATION:
Gene surgeon

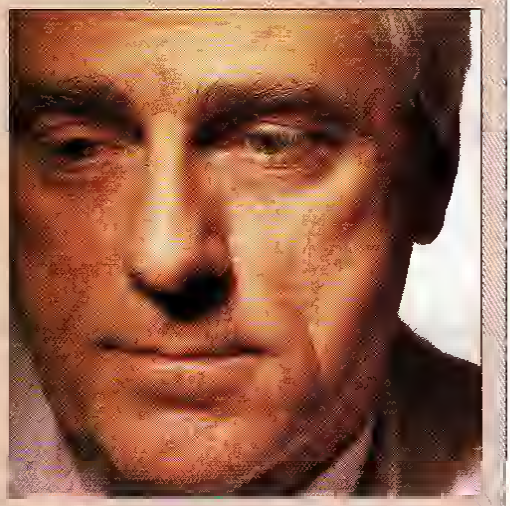
"OPERATIONS" DONE:
Nine for hereditary diseases
12 for cancer patients

FAVORITE BOOK:
Self Renewal, by Gardner

ADVICE TO LAB SCIENTISTS, I:
Molecules have minds. Get inside the minds of molecules; master them. Sooner or later they will give up and do what you want them to.

ADVICE TO LAB SCIENTISTS, II:
If your laboratory gets too big for you to do your own science, then make it smaller.

FUTURE OF GENE THERAPY:
If there are many benefits and few risks, gene therapy might eventually become as commonplace as antibiotic therapy is today.



paired that he was forced to live inside a germ-free capsule. Anderson and collaborators R. Michael Blaese and Kenneth Culver of the National Cancer Institute (NCI) combined some of the girl's white blood cells with those of an engineered virus. These genetically modified cells were then reintroduced into her bloodstream, where it was hoped they would multiply over the coming months, gradually restoring the functioning of her immune system.

Although still too soon to predict the ultimate success of this much-heralded trial, the physicians are very encouraged by the child's progress. She is better clinically and many of her immune function studies are improving, some into the normal range. Another ADA patient, a nine-year-old girl, began treatment on January 31, 1991. Early results suggest that she, too, is improving thanks to gene therapy. The investigators now believe this general strategy promises to have applications far beyond the treatment of rare hereditary diseases. Since genes code for vital body chemicals, Anderson thinks gene transfer techniques will eventually be used to "trick" cells into releasing drugs useful in the treatment of almost any disorder—from AIDS and cancer to heart disease and ordinary aging. Inserting the gene for insulin into the B cells of the pancreas might enable the diabetic patient to synthesize his own internal source of the hormone, eliminating the need for daily injections.

Raised at the edge of the dust bowl in Tulsa, Anderson was a prodigy. His passion for science burgeoned at age three, and by the end of grade school, he'd consumed every technical book he could find, including college-level medical texts. As a Harvard University senior at seventeen, he took one of the first courses linking DNA to genetics. The instructor was James Watson, the Nobel laureate who only four years earlier had codiscovered the chemical structure of DNA with Francis Crick. A year later, Anderson went to Cambridge, England, to continue his genetic studies with Crick. He completed his M.D. at Harvard in 1963 and two years later moved to the National Institutes of Health, where he's been ever since.

At NIH Anderson discovered the specific factors cells use to initiate protein synthesis, while his clinical studies led to breakthroughs in the treatment of deadly hereditary diseases. He championed the use of iron chelators for removing excess iron from the blood of thalassemia victims, which dramatically extended the lives of these patients. With the advent of gene-splicing techniques in the Seventies, Anderson intensified his efforts to devise better ways to get genes into cells. Using a hair-thin needle guided under a microscope, he pioneered the microinjection of genes. From the mid-Eighties on he used retroviruses to ferry genes into human chromosomes. And most dramatically, he has brought gene therapy to clinical use.

Whether confronting a problem in scientific technique or an obstacle in personal life, Anderson won't let go of a challenge until he's brought it to ground. A story from his youth is telling. To overcome a terrible stutter, he joined a debating team. Surviving this baptism by fire, he emerged as a champion debater in Oklahoma. Later, he took up Tae Kwon Do, a form of Korean karate, and attained a fourth-degree black belt. In 1988 he accompanied the American Tae Kwon Do team to the Seoul Olympics as their chief sports physician.

Kathleen McAuliffe first interviewed Anderson in his office and later in the more relaxed environment of his home. Well ... relaxed for French Anderson. Afterward, he went to his cellar gym to practice karate, demonstrating once again his iron will—and iron fist.

Omni: Tampering with genes—even for treating diseases—has aroused widespread concerns. Do you think those fears are inflated?

Anderson: It's clearly an emotional issue. Jeremy Rifkin [outspoken critic of genetic engineering] has fanned those concerns by exaggerating the risks. But he wouldn't attract so much media attention if society didn't have fears in the first place. Yes, I am concerned. My mother is concerned. The athletes I accompanied to the Olympics are concerned. It's bad enough to have your mind manipulated through advertising, or into eating artificial substances in foods. So the notion of manipulating genes—which make us who we are—is frightening. I feel strongly that gene therapy should be applied only for the treatment of disease. Very firm lines should be drawn to ensure that genetic engineering is used for no other purpose. That's been my position for twenty-five years.

Anderson: I believe an excellent system is in place for reviewing protocols and that doctors in this area are following a very ethical path. The long, involved process of gaining approval for the first human gene therapy trial is testimony to the numerous safeguards in place. This [he points to a document bigger than a Manhattan phone book] was the earliest draft of the protocol for the experiment. The Recombinant DNA Advisory Committee and half a dozen other regulatory committees studied it. Several reviewed the experiment twice and numerous public hearings took place with TV crews present. In the end, virtually every reviewer voted to proceed with the experiment. Even Rifkin complimented us on the care we took in preparing the Informed Consent Document that lays out for the patient all the risks and benefits of the procedure.

Omni: Why did you choose a patient with ADA deficiency, a very rare disorder, for the first gene therapy trial?

Anderson: In the Seventies I initially targeted a more common hereditary disorder—thalassemia—for the first trial. Kids with the disease produce abnormal hemoglobin [the blood molecule that transports oxygen]. Those pictures on the wall are of Nick and Judy, my first two patients with thalassemia. It's a fatal disease, and both died years ago. Untortunately, thalassemia turned out to be too great a challenge for us then because the instructions for producing hemoglobin are encoded in several different genes.

Omni: Isn't it distressing talking to these desperately ill children?

Anderson: I'm much more comfortable with children than adults, who tend to maintain a protective front. Kids talk about things important to them. Death and suffering are very real issues. Yes, I'm very comfortable talking to them about dying. I interact well with sick children. I can just feel with them.

Omni: Why was ADA deficiency a better disease to target than thalassemia?

Anderson: ADA, which stands for the enzyme that malfunctions in these children as a result of their genetic defect, involves only one gene. Without adenosine deaminase, the body cannot produce new T and B lymphocytes. So ADA kids suffer from severe combined immunodeficiency and need to be protected from infections.

Omni: How is gene therapy done?

Anderson: We withdraw the children's white blood cells and put into each cell a healthy copy of the gene for the ADA enzyme. We'd already genetically modified monkeys' immune cells, and after we reintroduced the white blood cells intravenously, the animals actually produced human ADA in their bloodstreams. That positive result convinced us we were ready to begin treating a human with the disease.

Omni: Could you be guilty of rushing ahead too quickly, as critics claim?

Anderson: Some patients with ADA might have been helped had we proceeded three years earlier. Richard Mulligan [at the Whitehead Institute for Biomedical Research in Boston] is the main scientist opposing our group. And from his perspective, he is right. But as a Ph.D., he doesn't have the experience of an M.D. doing rounds on a pediatric ward every day who knows that ninety percent of medicine is an art—not a science. That makes a scientist uncomfortable. So he felt our ADA gene protocol was premature. But the science was actually much further developed at the outset than is the case for most successful therapies.

> "The child's T cell count is normal for the first time in her life. And we can isolate gene-corrected cells making ADA directly from her bloodstream. We could not be happier."

Omni: Were you nervous on the day of the trial?

Anderson: Extremely. Even though the event itself was very anticlimactic. I mean, hanging up a bag of blood cells and intravenously dripping them into a patient happens ten times a day in that intensive care unit. And that's just one of many medical wards here, and we're just one of thousands of hospitals.

Omni: Didn't you worry she might die?

Anderson: Not from anything related to the procedure. I did worry that she might get a blood clot in her lungs or develop some other rare, life-threatening condition during the trial, which would have been an absolute disaster. I mean, if the first patient died while genetically modified cells were going into her body, who would agree to be the second patient? It could have set gene therapy back a decade.

Omni: What are the indications that the gene treatment helped?

Anderson: At this stage, there is every indication she is doing well. No, better than well—she is doing beautifully. In every way we can measure she is improving. Her parents are delighted because she is no longer sick all the time. In fact, she's just been sick once and that was when the whole family came down with flu. She was the first to get better! Her parents couldn't believe it. They were still sick in bed and she was running around playing. They say she smiles and laughs a lot more than before. As far as laboratory measurements are concerned, her T cell count is normal for the first time in her life, most of her immune function studies are improving, and some are now in the normal range. And we can isolate gene-corrected cells making ADA directly from her bloodstream. She has never shown any serious side effects from any of the infusions. We could not be happier about the way things are going. Our second patient, a nine-year-old girl, has had two infusions. She is also doing very well and the first preliminary data on her appear to show that she is improving.

Omni: How many more patients are you going to treat?

Anderson: That's Mike Blaese's decision, since he is the PI [principal investigator] on the protocol. But our plan is to add another patient at the end of the summer and maybe one more at the end of the year.

Omni: Does the treatment carry risks for problems later on?

Anderson: To introduce genes into the patient's cells, we use a vector derived from a retrovirus that can cause leukemia in mice. We snip out most of the retrovirus's genetic material so it can't cause disease. But there is always a remote possibility that when the new gene is inserted inside the patient's cells the process might cause cancer many years later.

Omni: Before the ADA trial, your group introduced a foreign gene into ten adults with advanced melanoma. The gene itself was not intended to have therapeutic benefits, so was this early trial done basically to show that gene transfer was safe?

Anderson: In part, yes, since the risk to a terminal patient is almost infinitesimal. But another major motivation was to obtain information that could help medicine better develop cancer treatments in the future. Mike Blaese, our ADA expert at NIH, saw that our gene transfer techniques could help Steve Rosenberg at NCI refine his new cancer therapy and got us all together. Rosenberg removes cancer-fighting white blood cells called TILs [tumor infiltrating lymphocytes] from the patient's tumor. In the lab those cells are multiplied ten-thousandfold using the growth factor

CONTINUED ON PAGE 90

STIGMATA

Prelude

And everywhere I look upon the Sphinx's skin,
memories spin, they form from the formless..

At the lost horizons of New New Guinea, in the forgotten highlands of Papua, the Koranga River tumbles wild as the riprap that fans into her valley from the sheerest mountainsides. She spills not far from the coast, not far from a world still trying to adjust, yet quite distant in such a riotous terrain where fresh growth reaches out and strangles you with its verdant grip. Along her banks sits a lone outpost of civilization, a desperate foothold of subsistence, and pig farmers, and the miners who crush gravel for its gold.

There I drowned—in cheap liquor—my memories of a woman's brown eyes. There I bared my torment over the unscalable limitations of love. And there I sought Wutai, a man who owned the town and had a reputation for knowing every person, every crazy tale that passed along the Koranga. In this case, a rumor that a powerful faith had sprung up in the jungle depths, a back-to-the-roots religion of animism and rebirth in nature, a truth that might free me from the remorseless grip of what obsessed my spirit. Wutai and I were destined to bargain, but I knew little of what I bargained for.

1.

In the mutant rain forest where everything dreams, yet nothing sleeps,
in its replenished interior that is the shade of the soul,
where ancient fires still rage and sputter dead,
I sometimes see my own death shapeshift before me,
a flashing vision

On the night I found Wutai, with monkey calls keening through the treetops, with a waxing moon that sparked silver fire in the clouds about Mount Kaindi, and after swelling my courage with shots of Wutai's rum, I sat on the steps of his canteen, talking with him, waiting for a guide Wutai expected soon. A seasoned explorer who Wutai would hire out to me for a price, and who he guaranteed would lead me to Bulolo—the mad bishop of this faith I sought. I watched the incandescent pupils of headlights scythe through the streets lined with candy-colored huts, with flaking attempts at cheer. The vehicles turned off, always false hopes, I twitched as I cursed. Tired of sitting and drinking, bone sore from waiting on bare facades in the abandoned outback of No Place. Waiting for my rapture, my savior. I knew something had better happen, and sooner than the next drink.

FICTION BY ROBERT FRAZIER

EVERYTHING DREAMS, NOTHING SLEEPS.

Inside, the band blasted through another loud, lurching song of joy
Thatched roofs lifted, the walls of the building seemed to sway
seductive as hips on their block pilings. I leaned against the steel rail,
stretched my legs along the length of the step, and turned my face to the door.
Strung over the dance floor, Christmas lights flickered like heat wasps as
the six-piece group segued to a staccato, reggaelike medley
Weathered men in stiff chaps brushed their electricity against giggling Lolitas.
A bar girl named Mani poured Wutai and me a round of black coffee.
Wutai, sallow-faced, with eyes hollow from smoking coca paste, slurped his.
I held mine up, hoping to divine my future from its calligraphies of steam.
Mani lingered at the threshold and stared at me with a pouty expression,
a smoky emotion that all women here bore like a cross against their bosom,
a sign that a man must interpret before offering up his heart to them.
Even in this regenerative paradise, the soul suffered its cloisterage.

Music stopped in an abrupt decay of drums and guitars. A brownout.
A woman in a blue top stepped from the shadows and confusion with a cigarette,
dismissed the girl, and got a light off me with a quick penetrating look.
When she disappeared again into the steamy mass inside, I followed her
compact movements with an appreciation born from years of insomnia.
"You like that one, eh?" asked Wutai. "She's half native."
"Just watching for the sport," I said, half in truth. "Spectator sport."
"Good. Mani wants to fuck you. It's okay. She's clean, and she likes it quick."
He gestured as if tossing off lines to an advertisement. "And she has spirit!"
"Spirit is good," I said. "But I like it slow, and with conversation. I like mystery."
I stopped talking then. The emptiness had pooled inside me, pressing to get out.

2.

I sometimes see my own death shapeshift before me,
a flashing vision
of scales patterned in a lambent bronze,
in a stream of rays that runs liquid as the days.

The generator kicked in, and the bandleader stepped to a big microphone.
Before he could sing, the woman in blue stumbled out—shoved past us.
Three surly men corralled her near a red flatbed truck with boarded sides.
The woman sank to her knees in the mud of the parking lot. She swore.
One rancher stood over her, spoke in pidgin that clucked from his throat.
She laughed like a madwoman, saying something about paying for drinks.
The man raised his fists and shook them. His words were unintelligible growl.
She laughed again, taunting him in a voice that I heard as a toucan's squall.

HIS IRISES DARK AS SAPPHIRES

The man hit her, quick and deliberate with the flat of his palm.
She bellowed. She wasn't an animal that he could buy and sell.
She moved to stand up, but he hit her again with a sweeping backhand.
His friends tried to subdue him, but he was incensed now.
Drunk enough to rage with mean spirits, to do damage. I stepped to the ground.
"It's not your fight," Wutai warned me with a grip on my shoulder.
I shrugged him off. Everything had become a struggle for me.
I slid across the wet earth, wove through puddles with a sinuous gait,
materialized between the rancher and the girl as he raised his fist like a hammer.
"You savvy, this stop," I said. The man dropped his hand to his waist.
A flash of metal arced toward me, lashed out, catching my wrist,
and I followed each scintilla of reflected light, each grain off the blade,
as I swung an elbow up under the man's forearm and drove outward.
With the knife deflected, I jabbed hard to his midsection.
The rancher staggered back, a groan exhaling from his lips.
I connected with a solid boot toe that raised his manhood six inches,
sent him sprawling like meat against the side of another vehicle.
He collapsed as might a seaport village under the monsoon rains.
I started to shake, my legs barely holding me as I walked away.
The girl ran off, cupping her bruised cheek and cursing along the street
until I could no longer hear her over the drunken croon of the bandleader.

I sat beside Wutai, inspected the long gash down the back of my hand.
Cut to the bone and gristle, but little blood—as if the wound grew there,
and the incision had only served to unfold its clean pink secrets.
Wutai removed a hat banded in grime and wiped the sweat from his puffy face,
blotting it from his creased jowls with a handkerchief mildewed by blue spots.
"Was it worth it, mister? You didn't even get the girl."
His irises looked dark as sapphires where the lights caught on their surfaces.
"And now you must worry about contamination in such a wound.
Out here, the spores can root through your marrow, seize your blood."
Wutai spoke with such sangfroid it sent a chill spiking down my back.
Hadn't he warned me that such a problem might occur?
I felt that he had indeed known the outcome of the fight.
That he prefigured every event that occurred in this godforsaken hole,
every round of Saturday night seduction and duplicity and murder,
and every pincer of the rain forest's campaign against man's occupancy.
"Now, what about Mani?" he said. His eyes turned depthless, indecipherable.
I shook my head. "I'm through with sex. I'm here for salvation."
"But my guide will pass through. Tomorrow, maybe. Maybe the next day.
Your payment will not be lost. Mani is here tonight!"
I ignored him, discovering that another gash opened along my forearm.

THE RIVER BUILDS HER WHITE ANGER

I accepted pain. Began to stutter. To itch where more cuts burned
like an unrequited passion. I told myself that I deserved them.
Wounds of guilt. Of yearning. Of my true caring severed by a woman's fear.

3.

It is a Sphinx that lifts the world upon its back and growls
Its veins are road maps that lead nowhere,
its breath a cipher

Wutai said, "Sometimes men aren't what they seem. But they are still men."
He looked puzzled as he spoke, then smiled as he pointed toward the dark
shapeless canopy engulfing the town. "You know the trees are weak.
They have grown very shallow roots in the jungle, even the giant *klinki*.
Despite their girth, a cable and two jeeps can pull them over.
Ah, a man's resolve is no different. A man needs love to carry on."
My wounded hand palsied. I caught it in my other, squeezed it hard.
The pain spread tongues of warmth through me, replacing my destitution.
I wanted to say, "A man can survive on his pain, if he makes that choice."

Wutai patted me on the shoulder with an air of patronage.
"You look pale, mister. Perhaps we should go inside to the rum?"
As we stood, I heard a strangled cry from the brush that bordered the canteen.
A tribesman ran breathless into the lot, tripping and landing facedown.
He thrashed the mud with his arms, staggered up, and ran straight
into Wutai, who caught him by a mop of stringy hair,
now caked into muddy dreadlocks across his painted chest and arms.
A ragged hole remained where the man's nose had been. His ears were lace.
The muscles on his face danced as if bees swarmed just beneath their surface.
The very top of his skull supported a fungal mass that glistened in the moonlight.
Wutai said, "This is not the guide to Bulolo. But he is certainly of their church.
Perhaps the forest has brought this one to you as an omen."
Wutai sat again with a look of apprehension veining the slack of his face.
His voice sounded more precise, more educated than he'd first let on.
"Sit again, mister. We will comfort this man. And Wutai will talk."

"Far at the depths of old Papua, where the river builds her white anger,
Bulolo keeps a church carved from the heartwood of a massive *klinki* tree.
And around it, living roofless in the canopy, his followers congregate."
(At the mention of Bulolo, the native slumped forward and lay at my feet.
He breathed in deep, gasping rhythms while Wutai continued his story.)
"The novices of Bulolo do much worse than *kai-kai*, than eating men.

THEIR SKIN DROOPS IN WATTLES

They feast on the forest. edible barks, fox-fire fungi, the rodentlike things
They drink such nectars that infect them with unnamed contagion,
or with hallucinatory trances that are the dreamtime of the forest.
They seek to commune with the virulent growth that seeds their land.
And in doing so, their fallen spirits may rejoin the perfection of nature,
may participate in the rebirth of the world through change and regeneration."
(At this, the native's back began to heave, the skin bunching in cabled knots.
I watched the musculature writhe and seemingly align anew.)
"And this takes its toll on any zealot," Wutai said. "For they are all zealous.
Their skin droops in wattles. Their hair blooms or falls out forever.
The bacteria swarm in colonies through their pores, annexing the flesh.
They become something more than a man, and something much less.
They seek oneness and rebirth, but I am unsure what they truly find."

The native's skin began to alter in hue before me, to a dull yellow-red,
the color of an open wound suppurating with pus and blood.
From this base—nutrient rich—fine rhizomes sprouted and tendriled,
sooty black as the branching air passages in a rock miner's lungs.
They matted to a mycelium knotted with buttons of tiny orange fruit.
They mounded on him, formed a topography of the mutant landscape
crawling with faceless stick figures, seething spore bearers.
These things embraced then fought, mated and—it appeared—died.
Finally, they fused into a winged beast, a panther with the skin of a boa
and the wings of a great bird, and this image birthed a bronze-colored cub
as the man moaned in something resembling a wind-borne chant.
Thus, Wutai's monologue was made corporeal before my eyes.

4.
its inscrutable eyes spin mandalas that drift and blue-
shift in toward Armageddon

Within minutes the native had healed, a process in which the growths shrank,
withdrew from his back, and the man stood on both feet in good vigor and
shook Wutai's hand. He then staggered to some other rendezvous, enslaved,
perhaps, by a need to convert the world through his obeisant displays.
I sat with Wutai in silence and watched the monkeys dance on the shoreline,
acting out a primal play of lust conquering, of lust spurning.
What riddle had the rain forest placed before me in the body of that man?
And Wutai, was he a facilitator in this riddle? Or a separate challenge?
My skin crawled with emotion, perhaps a foreshadowing.

THE NOVICES FEAST ON THE FOREST.

I realized that my bargain with Wutai was not what it had first appeared
that his offer of a guide was an offer of himself, of his instruction
and for him, my pilgrimage here was to Wutai, not to the bishop or to the wilds
Bululo's trail guide was no more than a figment of Wutai's dementia
No man explored these jungles for long, no man returned unmodified
Certainly, no man would come to lead me physically to my own healing
I had not sought salvation so much as I'd sought escape
I had not sought truth so much as I'd sought an elaborate lie
Wutai had sensed this, and offered a woman and some down-home wisdom.

I walked down to the river's edge, skipped stones into its caldron pools
The mist gathered, wet my eyes, and for a moment my resolve broke
I knew then I must find the center of the rain forest for myself,
accept its changes on me as I had accepted the wounds of a shattered love
of a woman I'd left far behind in the cubicled cities of America,
of a woman who had known my heart but feared the power of her own,
who feared the thin illusion that my life was staid and stable,
feared rejection and its loneliness where none was possible from me,
feared the intensity I had leavened into friendship.
I must accept that we could've loved, could have reached unscalable heights,
yet we'd feared—we *both* feared—the raw, exposing power of that act.
These were inescapable insights. Yet it seemed I could escape them.
And in the mutable heart of darkness, I would act out their stigmata,
a broken man laboring at every moment to live with my truth,
my flesh opening for each new spore to implant
the solace of its corrupting visions.

Coda.

In the mutant rain forest where everything dreams, yet nothing sleeps,
in its replenished interior that is the shade of the soul,
where ancient fires still rage and sputter dead,
I sometimes see my own death shapeshift before me,
a flashing vision
of scales patterned in a lambent bronze,
in a stream of rays that runs liquid as the days
It is a Sphinx that lifts the world upon its back and growls
Its veins are road maps that lead nowhere,
its breath a cipher,
its inscrutable eyes spin mandalas that drift and blue-
shift in toward Armageddon
And everywhere I look upon the Sphinx's skin,
memories spin; they form from the formless ∞

ANTIMATTER

UFO UPDATE:
Belgium's military has begun to work hand in hand with private groups to track UFOs

Life in the tiny kingdom of Belgium is anything but harmonious. In fact, ferocious rivalry between the Flemish up north and the Walloons down south has dominated Belgian politics for centuries. But according to UFO activists, a mysterious triangular craft may do much to change this. Belgians from the north and the south, it seems, have put aside their differences to form what some call the most coordinated UFO investigation to date.

It all began on November 29, 1989, when hundreds of people from two Belgian towns—Eupen and Wavre—reported sighting a dark gray deltoid shape, one white light per tip, gliding across the night sky. The mysterious object, with a wingspan of 50 to 100 meters, was apparently silent, says Michael Bougard, president of Belgium's Society for the Study of Space Phenomena (SOBEPS), a nonprofit citizens' organization. "And no one reported seeing it land."

By March, adds Bougard, "everyone from farmers to teenagers to high-ranking military officers and professors claimed to have seen the UFO." In addition, on March 30, controllers at a radar station in Glons detected a foreign object on their screens. They quickly contacted colleagues at a station in Ghent. The second station confirmed the presence of a slow-moving blip.

"At this point it had become a scientific problem deserving serious investigation," says Professor Leon Brenig, a physicist at the Free University of Brussels. "It couldn't be steel coming back into the atmosphere because the edges were smooth, not bent. It couldn't be a NATO aircraft because its capacity for flight seemed to outreach current technology. I decided it was worth my time."

Apparently the military agreed. Belgium's air force contributed two F-16's, an expert crew, and instruments to a hunt later that spring. Scientists and citizens participating in the effort formed four watch groups, each responsible for calling sightings in to headquarters, an airport southeast of Liege. The airport tower, in turn, alerted pilots, who flew planes equipped with infrared cameras in pursuit of the triangle. The pilots failed to get photographs because of the deltoid's reported great speed. Nonetheless, the effort goes on. Engineers and physicists at the Free University are analyzing radar images of the object. Belgium's air force training school, the Ecole Royale Militaire, is analyzing UFO photos with computers. And botanists are examining burn patterns in fields where the triangle was reportedly seen.

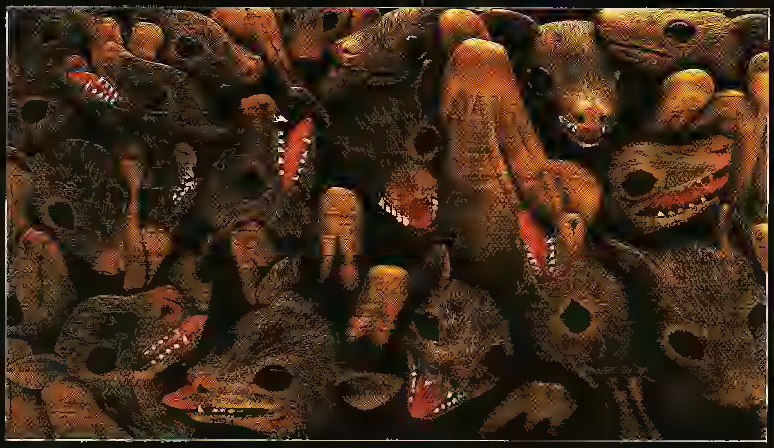
"This investigation is unprecedented—it's gone further than any I know of," says Walter Andrus, international director of Mutual UFO Network, Inc. (MUFON). "We are impressed that Belgium's military cooperated. That is a major step." Indeed, adds Lucean Clerebaut, SOBEPS's secretary-general, while the French have a government office dedicated to UFO study, "this is the first time that a national authority has worked with a private society in researching UFOs."

Whether or not the Belgians eventually unravel the mystery, the unusual official effort may affect the perception and pursuit of UFOlogy worldwide.

According to MUFON's Andrus, for instance, in the United States, "every military and intelligence agency we can identify has been involved in investigating UFOs since 1947, but they will not share their information. If nothing else, we hope the efforts of the Belgians will embarrass the U.S. government into admitting some of what they know," he says.

—BETH LIVERMORE

ANTIMATTER



SUNSHINE STATE VAMPIRES

If drastic global warming continues, vampire bats from Central and South America may be moving north into Texas and Florida. According to bat fossil expert Gary Morgan of the Florida Museum of Natural History, vampire bats lived in Florida before moving south at the end of the last ice age some 10,000 years ago, and they could return if temperatures rise. To make matters worse, he adds, the bats would probably enjoy feasting on Florida's cattle herds.

Morgan's speculation is supported by Don Wilson, director of biodiversity programming at the Smithsonian's National Museum of Natural History. Wilson thinks it is *already* warm enough in southern Florida for the vampire bats to arrive.

"Vampire bats live quite comfortably in northernmost Mexico, and temperatures there are not very different from temperatures in southern Florida. As global warming continues, Florida will become more attractive to them," says Wilson, who adds that vampire bats have been reported as far north as Texas.

What of Gary Morgan's controversial statement about the bats picnicking on Floridian cattle? "Vampire bats do feed off of cattle," Wilson says, "and they tend to attack the same cow in a herd over and over again. You might look at a herd of cows in Mexico and one cow in a herd is very scarred."

There has been speculation that the bats could come in on boats from Central America. "With all the stuff that comes into Dade County," Wilson says, "I wouldn't be surprised if bats came along."

—Mark Chorvinsky

DRACULA'S RING

Romanian-born Vlaicu Ionescu, a sixty-nine-year-old artist, writer, and art historian now living in New York, was handcuffed and beaten in his apartment by two men who stole his extensive art collection in the summer of 1989. Although the thieves snatched about 60 art objects, they seemed to be particularly interested in a fourteenth-century ring. The simple three-quarter inch-wide bronze ring wouldn't be worth much at all if it weren't for its history—it once graced the fingers of Vlad Dracula and his son, Vlad the Impaler. Although he didn't suck blood, the younger Vlad mutilated and impaled people alive by the thousands, perhaps inspiring the legend of Count Dracula.

THE SIMPLE BRONZE RING ONCE GRACED THE FINGERS OF VLAD DRACULA AND HIS SON, VLAD THE IMPALER.

Ionescu purchased the ring from the widow of a Romanian poet. Rumor has it that her husband may have obtained it from the archaeologist who excavated Vlad the Impaler's grave in the Forties. "The round signet ring is emblazoned with the image of a raven with a cross on its tail," Ionescu says. "It was believed to be without an inscription, but I noted that points around the raven are grouped in unequal numbers and correspond with the letters that spell out Vlachia, the ancient name of Romania."

Two other 500-year-old Romanian rings were also stolen from Ionescu. "The motif on those rings was the basis for the first coin in Romania, so all of these rings have extraordinary historical value," he says, "but only to Romania."

Even though Romania may have wanted the rings badly, clues point to South American suspects. The robbers claimed that if they didn't get what they were there for, their entire families would be killed. That fact leads New York City police detective Richard Byrnes to suggest that Dracula's ring may be sitting on a Colombian drug lord's finger. "Drug kingpins often take retribution on entire families," he explains. Although he has no hard leads at present, Byrnes says the theft of Dracula's ring is a case that will not die. "It's sitting in front

of me every day. I'm thinking about it all the time and just waiting for that one little bit of information we need to lock this thing up."

—Sherry Baker

THE ROUND SIGNET RING IS EMBLAZONED WITH THE IMAGE OF A RAVEN WITH A CROSS ON ITS TAIL. POINTS AROUND THE RAVEN CORRESPOND WITH LETTERS THAT SPELL OUT THE ANCIENT NAME OF ROMANIA.

BELIEVE IT OR NOT

Kim Mikules has an offer he thinks you can't refuse. Al-TRAD, the organization he works for, will give $500,000 to anyone who can produce evidence of E.T.

Since the offer appeared ten months ago, 15 claims per day have poured into the Al-TRAD mailbox. But only one, a severed hand, has purportedly been authenticated as extraterrestrial, according to Mikules. The payoff? The hand came in so recently, Mikules says, that Al-TRAD hasn't had time to make good.

So, are these guys for real? Mikules says he could drop some names of backers, but that would be a violation of his agreement with Al-TRAD.

Walter Andrus, who heads up MUFON, isn't impressed. Over MUFON's 20-year history he has seen groups come and go. "Take Al-TRAD with a grain of salt," he says. Don Berliner, of The Fund for UFO Research, adds, "It sounds like another nutty operation to me."

Still, Mikules isn't worried. "Quite frankly," he says, "we have the money and the power to do practically anything we want."

—Paul McCarthy

SPACE LOTTERY

A California marketing consultant named Volney Stefflre has launched a new world lottery, one in which the lucky winners will get to go live in outer space. Founder of the International Society for the Exploration and Colonization of Space (ISEC), Stefflre bases his lottery on the pioneering ideas of Gerard K. O'Neill, a Princeton scientist and author of *The High Frontier*.

In that popular book, O'Neill described the workings of a 10,000-person, self-sustaining space colony that would look and smell like a small Midwestern town complete with hills, valleys, and gentle rainfall before dawn. O'Neill's proposed designs were so elegant that they became the subject of countless studies and several congressional hearings.

Despite the potential, funds for O'Neill's concept have remained scarce. Enter Stefflre with his stellar experience in advertising. His idea: bootstrapping O'Neill's plan through yearly lotteries he hopes will escalate to the $100 billion mark by the year 2000. "Every time they drop a bomb," says Stefflre, "ticket sales go up."

O'Neill, who retired from Princeton University to become the founder and president of the Space Studies Institute in Princeton, never responded to any of Stefflre's letters and proposals of partnership, but he takes a guardedly optimistic view of the space lottery. "My work concentrates on science and engineering, not marketing," O'Neill says. "But I wouldn't want to rule out Mr. Stefflre's ideas."

NASA, however, is skeptical. "There's no question that at some point there will be people living in space, and O'Neill's ideas will be transformed into reality," says Vera Hirschberg, a senior public affairs officer for the Office of Exploration at NASA. "But I don't think that an independent civilian grass roots movement will be able to raise the dough."

Yet Stefflre remains undaunted. His organization already has 105 members, and he has some catchy bumper sticker slogans in the works. "Everyone is longing for a bigger dose of material wealth and security," he says, "things that will be in abundant supply in space."

—Tracy Cochran

"Nothing, Mom!"

The Artist

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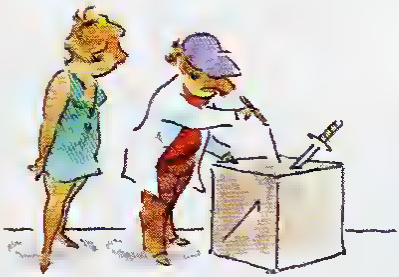
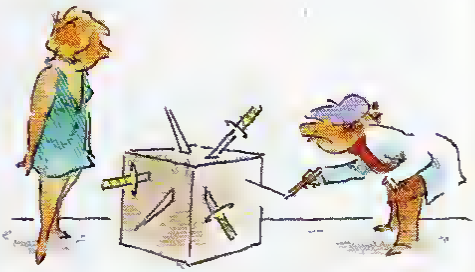
How come he gets half the profits for just sitting in a box

It's his talent

His ability to reach across the footlights and hold an audience spellbound





Does he always blubber this loudly ?

Only when he's trying to reach the balcony

SPACEWARD

CONTINUED FROM PAGE 46

erty-stricken newcomers seeking Utopia. There may be a lesson here for space development.

Government funding also seeded private expansion in irrigation projects in Washington State. Back in 1919 the *Wenatchee World* newspaper in Washington proposed a massive project to tame the Columbia River by building a huge dam at the head of Grand Coulee, a large channel carved by Ice Age floods. The object was to irrigate the sagebrush plain of south central Washington, which was too dry for anything but grazing.

Public reaction at the time was typified by H. E. Riggs, president of the American Society of Civil Engineers. "[Grand Coulee Dam is] a grandiose project of no more usefulness than the pyramids of Egypt," he said.

Still, the project gained supporters through the Twenties. The Great Depression provided the ultimate stimulus for construction, because of the thousands of jobs it created.

Economic soothsayers who foresaw no market for the electrical power were spectacularly wrong. In fact, during World War II, Grand Coulee hydropower proved so valuable to the growing war effort that construction of the irrigation works was postponed until after the war.

Once the irrigation infrastructure was built, the government held drawings for the new lands. The winners signed contracts with the government that provided for repayment of a mere 10 percent of the irrigation infrastructure costs, typically over a 50-year schedule. Hydropower sales covered the other 90 percent of the costs.

Big dams are unpopular now. A complacent later generation free of any experience with major economic crises and equipped with the economic surplus to spend on environmental issues finds it difficult to relate to the popular enthusiasm and extravagant hopes that attended these early projects. But these projects, and others like them, were eminently successful in both economic and human terms.

The dams have made it possible for people to live where they could not live before. Phoenix is now a major urban area largely because of the Salt River project. The lower Colorado River valley below Hoover Dam is also becoming a major population center. The idea that millions of people would want to live in a desert would no doubt have flabbergasted Daniel Webster.

Historical precedent shows that government and private enterprise can work together successfully on massive projects and even produce beneficial results that neither side could have achieved without the other. Private enterprise is extremely efficient in known markets, and even in risky markets where the capital investment needed is not restrictively high. But historically, private enterprise just has not worked for major pioneering development, especially when the very economic infrastructure must first be built. Even in the free-wheeling days of the Gilded Age, government sponsorship provided the impetus for many projects.

Still, government sponsorship can be bungled, as it has been bungled many times. Historical examples suggest both productive approaches and mistakes to avoid. For example, imagine a project to build the first solar power satellite (SPS): a ten-mile-long satellite in geosynchronous orbit that will convert sunlight into electrical power and deliver it to an antenna farm on Earth. Here are some practical tips.

While it might be useful to grant a monopolistic charter to a consortium that will build and operate the SPS, make certain the charter contains a specific goal and a time limit for finishing the job. *Any* ongoing charter should be subject to periodic review. In the late 1600's, King Charles II of England granted a *perpetual* charter to the Hudson's Bay Company to explore and develop the Canadian wilderness. The company made so much money on the fur trade that it never bothered doing anything else.

The same sort of problem can result from creating a perpetual government bureaucracy. Federal involvement is justified *only* when a project is so high-risk and/or so costly that no private entity could afford to undertake it. Even then, the federal government's investment should be limited. Performance goals should be specific and clear. Once goals are met, no further government money should be spent on the facility's day-to-day operations. The cost of operations should be borne by the operators, not the taxpayers.

A massive SPS could be built from materials mined on the moon. Actual "land grants" are forbidden by the 1967 Outer Space Treaty, which prohibits any claim of sovereignty on celestial bodies. However, the same treaty also specifies that activities on those bodies must be carried out under government supervision. Under present law, the U.S. government could grant lunar mining rights to a company or consortium. Again, such a contract or grant should be reviewed regularly.

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Don't micromanage! Hoover Dam came in under budget and ahead of schedule largely because the contractors, who had a great deal of expertise, were allowed to solve their own problems. The government carried out some basic research on critical engineering, but its primary role was to provide specifications that the dam had to meet. The contractors were then responsible for meeting the specifications, and since they were on a fixed-price contract they had a powerful incentive not to overspend.

Market guarantees are crucial. The long-term market for the first SPS's electrical power should be specified just as clearly as its performance requirements. The government can withdraw when private entrepreneurs have a sure and steady market to serve.

Another way to encourage private investment in space: Pay off the infrastructure rather than grant it outright. The first SPS will cost in the range of tens of billions of dollars, it should be paid for by the power it generates, just as Hoover Dam and other projects paid for themselves with the electricity they generated. In fact, with current federal deficits, this may be the only way to finance major space projects such as power satellites.

"The government can't spend its way to prosperity" is a common saying. Perhaps so. But the federal government has, in the past, wisely invested in the development of the Western frontier. The same wisdom can be employed to utilize the best resources of government and private enterprise to develop the space frontier. ☒

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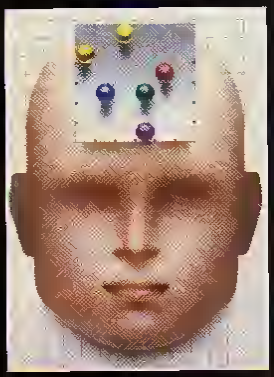

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GREENHOUSE

CONTINUED FROM PAGE 54

helping to bring temperatures back down. (On the other hand, clouds can also serve as traps for infrared radiation, thus an increase in cloud cover could strengthen the warming trend. This would be an example of *positive* feedback, which amplifies a situation rather than correcting it.)

What's more, warmer temperatures hasten the breakdown of methane into the less damaging CO_2, a beneficial process. But a rise in ocean temperature might foster the release of oceanic methane into the atmosphere, further heating it—another positive-feedback event. The warming of the seas would also reduce their capacity to absorb CO_2, making more trouble for us, since the ocean swallows up much of the CO_2 we put into the atmosphere now. This is balanced, however, by the likelihood that the oceans—which are vast thermal sinks that keep planetary temperatures stable—would absorb much of the increase in heat produced by greenhouse effects, thereby minimizing or even canceling out any global warming that might occur. Similarly, the emergence of immense forests in areas now too cold for vegetation—particularly the Arctic and subarctic tundra—might lead to a net planetary gain in the amount of CO_2 absorbed during photosynthesis. Or the warming of the frigid tundra could release the CO_2 and methane now stored in its soil in the form of peat, making matters worse.

Adding to the general perplexity is the argument raised by University of East Anglia climatologist T. M. Wigley in the British scientific journal *Nature* last winter. Wigley points out that the burning of fossil fuels releases not only the dreaded greenhouse gases, but also sulfur dioxide particles, or aerosols, which serve to reflect sunlight and moderate the temperature of the planet. A sudden and radical reduction in fossil fuel consumption, Wigley maintains, would diminish the cooling effect of the aerosols that the fossil fuels produce. And so a cutback in the use of greenhouse-effect fuels might actually *increase* the global warming trend.

The consequent rise in temperature could more than compensate for any cooling that a reduction in greenhouse gases would create, leaving us in even bigger trouble than we might be heading for otherwise. Robert Charlson, an atmospheric chemist at the University of Washington, calls this problem "a sleeping giant of a sort" and "something that has been missed" and the consequences are not trivial. "It is going to complicate matters in setting policy."

These feedback forces illustrate just how tricky the whole problem is, and just how uncertain our climatologists really are about what is likely to happen. Even after two centuries of serious study, we have only an approximate understanding of the forces that drive our climate. In many cases, we are not sure which is the cause and which the effect. During a 10,000-year warm spell in the last ice age, for instance, atmospheric CO_2 and methane levels were far higher than they were in the surrounding colder periods. But did that increase in greenhouse gases create the warm spell, or was it the other way around? No one can say. And a study of the Alaskan permafrost conducted by the U.S. Geological Survey shows a thawing of several degrees in the past 100 years but a drop in temperature of more than a degree for the period 1984–87 alone. One suggested explanation is that the shrinkage of the Arctic snow cover during the warming period of the Eighties has reduced the amount of insulation that the snow provides, allowing greater radiation of heat from the permafrost. So a warming produces a cooling, negative feedback at work again.

Whether all these intricate processes will cancel each other out, leaving our climate more or less unscathed, is something that only time is going to tell. We are indeed conducting a geophysical experiment with the planet as our laboratory, and the outcome is far from certain, despite the confidence that various theorists express. At the moment there are no facts, only speculations, when we talk about global warming. We have had no experience with greenhouse effects from which we can predict what's ahead.

Computer simulations alone won't give us the answers, nor are our meteorological records accurate enough over a long period of time to provide us with a clear view of what has actually been going on. Scientists can measure CO_2 concentrations in ancient times by looking at ice cores brought up from polar depths, but the weather bureau records of 1850 and 1900 and even 1950 are statistically unreliable because the samplings tended to be too small, and the methods of measurement often had built-in inaccuracies that make comparisons with today's weather misleading. If we aren't sure where we have been, how can we be certain about where we are going?

The middle-of-the-road scientific position, though, seems to be that *some* climatic warming will happen during the

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JULS1ONE

first half of the twenty-first century as a result of the changes in the atmosphere that we have already brought about—though it may be a mean increase of only a degree or so, rather than the 5° to 10° that the most extreme environmentalists are predicting.

A minor warming of that sort would require some local readjustments. Low-lying coastal settlements in marginal areas where flooding has traditionally been a problem might have to be abandoned. Rainfall patterns would probably change to some extent, and some of today's productive agricultural regions may experience water shortages. Middle-latitude zones might become too warm for efficient farming.

But these negatives would be balanced by corresponding positive changes elsewhere. Vast areas in Canada, the Soviet Union, and the northern United States, their development now hampered by cold weather, much of the year, would experience a beneficial access of warmth. What farmers in Arkansas might lose, those in Saskatchewan would gain.

The same with rainfall patterns. Regions now blighted by chronic drought would become fertile. All over the planet, the increase in CO_2 levels would make plant growth more vigorous. Seas now blocked by ice much of the year would be open to navigation. And so forth: not catastrophe but change. And we are an adaptable species.

Part of the problem of knowing whether global warming will be good or bad is our geophysical ignorance. "We don't even know within a factor of ten how much total biomass there is on Earth," said NASA scientist Gerald Soffen at a greenhouse effect discussion at the 1991 meeting of the American Association for the Advancement of Science. "Is life expanding or not? We can't say." Another AAAS panelist, botanist Lynn Margulis of the University of Massachusetts, added, "We have millions of species, each processing carbon differently, and we don't understand any of them perfectly. If we try to guess how life will respond [to global warming] we'd really be fools rushing in."

We should not, of course, rule out the possibility that we are indeed heading for catastrophic climatic events. But the conservative climatologists, who deny that these events will be apocalyptic, hold that it's unwise to launch crash programs of industrial cutback that might well have economic consequences for many countries far more serious than any climatic change that's in the cards. We need to wait for further evidence that a severe global warming is actually coming.

Meanwhile, as we await that further evidence, what can we do to ward off the worst-case scenarios? One smart move would be to try—within the limits of economic realities—to reduce industrial emissions and the use of fossil fuels in general. Not in any panicky way, with visions of the oceans covering our coasts and our forests turning into tropical jungles, but with a calm, clear-eyed resolve, based on the understanding that it's a dumb idea for any creature to foul its own nest. The junk we've been putting into the atmosphere can't possibly do us any good, and there's a reasonable chance that it can do us great harm. Therefore we should clean up our act, not by closing down the factories and switching overnight from cars to bicycles, but by zeroing in on the chief causes of pollution and finding rational ways of eliminating them, and by putting programs of energy conservation into use.

A halt in the indiscriminate destruction of forests in Third World countries would help, too. Those trees—the lungs of the planet—are one of the most powerful climatic moderators we have, and once they're gone, implacable deserts will replace them, tropical soils are surprisingly infertile and undergo dismaying changes once their forest cover is stripped away.

Another wise move would be systematic reforestation of areas already denuded. It isn't just that trees are pretty. They soak up CO_2—a forest the size of Alaska would take in a billion tons of it a year—and give off oxygen. Having them around is a fundamentally good idea.

These conservation measures, none of them so stringent that they will unsettle any nation's economy, may of themselves succeed in stabilizing our atmosphere. The worst-case greenhouse world isn't necessarily on the way. Prudent planetary housekeeping is in order right now. Hysteria isn't.

Because even now many of the processes that rule our climate are mysteries to us, many scientists are uncomfortable with the recent outcries for radical environmental reform. "Whenever you try to do this quickly, you run up against our ignorance and the quality of the data," says Michael Schlesinger, a climatologist at the University of Illinois, and his caution is echoed in many other quarters. We have greatly changed the face of our planet, but whether those changes have set a devastating climatic change in motion is something we simply don't know. For once, more studies really *are* needed. What we have to do now is to watch and wait. OMNI

CONTINUED FROM PAGE 66

interleukin-2. Then the TILs are given back to the patient. About forty percent of patients show at least a fifty percent reduction in tumor size. Ten percent have a complete response, there's no evidence of any remaining tumor.

Omni: For terminal patients, isn't that an incredible response?

Anderson: Yes. But why does the treatment work for some and not others? Rosenberg needed some way to get a handle on what was happening inside the body. He needed to know where those TILs were going. What they were doing. That's where our technology could help. We tagged the TILs removed from the patients with a retroviral vector carrying a bacterial gene. When those gene-marked cells were returned to the body, they functioned a lot like a radio transmitter attached to a dolphin. We followed the TILs, saw how long they lived, where they went. It worked beautifully and perhaps has helped us to identify a subpopulation of lymphocytes more effective in fighting tumors. These findings may help us develop more powerful treatments against some types of cancer.

For example, Steve Rosenberg has already started treating two patients with advanced malignant melanoma by infusing TILs that contain the gene for tumor necrosis factor, an anticancer compound. Although it's too early to see any clinical response—we are still in the phase one safety trial—these patients have shown no toxicity from the gene transfer. Other approaches for using gene transfer to treat cancer are now being developed.

Omni: When did you know retroviruses would work in gene therapy?

Anderson: By around 1983, I became convinced that they were the way to go. It was not a sudden revelation. I'd been talking with Ed Scolnick, then at NCI, about retroviral vectors since 1979–1980. But there were so many apparent problems with them. By late 1983, thanks to the work of Gilboa, Mulligan, Verma, Friedmann, Miller, Bernstein, and others, I developed a deep instinctive conviction that retroviral vectors could be made to work in human gene therapy protocols.

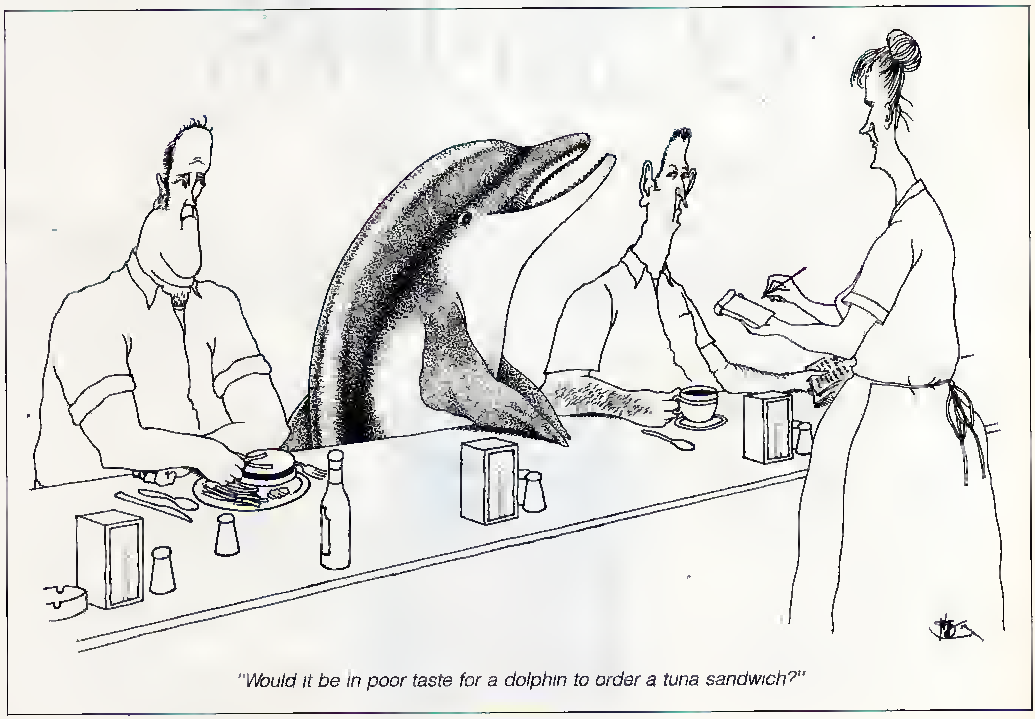
Retroviruses normally carry genetic information into cells; that's how they reproduce themselves. They evolved to do just that, so they're much more efficient than microinjection. With retroviruses we could get into millions of cells in one step. I should make it clear that I'm not the only person to have this idea. But, yes, most of the rest of the world thought we would never make it work in patients. Of course there were technical problems. There always are. But to me, the important thing was that I knew what ought to be done.

Omni: Why are you so confident your experiments will work?

Anderson: I've always had that ability. My conscious mind isn't so bright. I have trouble following lectures unless I know something about the subject. But when I get really interested in a problem, I take in all the information and totally immerse myself in it. My subconscious works on it all the time, and sooner or later it comes out. Sometimes I'll wake up at three A.M. with the idea for an experiment.

Omni: And it works?

Anderson: Ninety percent of your "brilliant" ideas don't work the first time. And don't work for a long time—the experiment may drag on for months or years. Francis Crick once said if there's a conflict between theory and data, the theory's more likely to be correct. Most scientists think just the opposite, but I'm more like Crick. If an experiment ought to work, I'm convinced it will work, and stick with it until it does.



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JUL91OP2

I'll tell you something more bizarre Molecules have minds They can tell if you're not comfortable with them if you're not really in control So they just won't work You have to get inside the minds of molecules and master them Sooner or later they will give up and do what you want them to You can try and try to no avail But once you finally get the system working, you can drop the experiment on the floor, scrape it up, and it will still work

Omni: How did you see the idea for gene therapy so long before the advent of genetic engineering technology?

Anderson: By my junior year in high school I was already thinking about the idea in its broadest outlines I wrote on my application to Harvard that I wanted to study the molecular basis of human disease Nobody even knew what a gene was at that stage By my senior year in college, however, we knew about this slimy stuff, DNA, that could alter the appearance and function of bacteria Working with Julie Marmur, I'd irradiate DNA with ultraviolet light, causing mutations in the molecule and then introduce it into bacteria This experimental manipulation would often change a basic property of the bacteria So it occurred to me then: If I can change how a bacterium functions by giving it new DNA, it ought to be possible to use the same strategy to help people suffering from hereditary disorders I began to study human genetic disease at NIH, joining [Nobel laureate] Marshall Nirenberg, who was working out the final stages of the genetic code in *E. coli*. When that project was completed, I announced I wanted to study hereditary diseases in man. Marshall was aghast. So little was known about human genetics then, he thought I was throwing my career away. It was only if you couldn't make it in *E. coli* genetics that you worked on humans. But that's what I wanted to do. So I said, "If you won't let me do what I want to do, I quit." Marshall did his best to talk me out of it but finally gave in and let me spend fifty percent of my time doing human work.

Omni: What sorts of advances can we look forward to in the future?

Anderson: We're trying to transfer genes into other types of human cells: hepatocytes [a type of liver cell], endothelial cells [lining blood vessels and the heart], and bone marrow stem cells. A host of potential applications could come out of this work. Endothelial cells are especially attractive targets because any protein produced by them will be secreted directly into the bloodstream. One protein we'd like these cells to produce is the anticlotting factor TPA [tissue plasminogen activator]. When a clogged or injured blood vessel needs to be replaced, doctors will graft in an artificial vessel. About three hundred thousand grafts are performed yearly in the United States, and one hundred thousand of them fail because a clot forms in the artificial vessel. David Dichek in my lab plans to line the artificial vessel with endothelial cells that have been genetically manipulated to produce TPA. We've done it with rabbit cells, and others have been successful with pigs and dogs. But the cells tend to wash off after a couple of days. When we find a better way to anchor them, these techniques will improve the success of blood-vessel grafts in humans.

We also hope to engineer insulin-producing cells for the diabetic or antitumor agents for the cancer patient. Perhaps someday we might genetically engineer cells to produce neurochemicals needed by psychiatric patients.

Omni: So gene transfer could provide a new drug delivery system?

Anderson: Yes. Drug companies now churn out millions of vials of drugs with half-lives of minutes or hours. Some must be injected several times a day or week. Today even diabetics who closely monitor their blood sugar levels still suffer debilitating problems, such as the retinopathy leading to blindness. Perhaps they can't regulate the drug dosage closely enough. By transferring a properly regulated gene for insulin into the B cells of the pancreas, we might avoid such serious complications. We hope to get the body to manufacture and release the appropriate amount of insulin at the appropriate time—the way a healthy body does. Within twenty years gene transfer techniques will give us another drug delivery vehicle.

Omni: Could gene therapy transform us into a new species?

Anderson: No. We have a hundred thousand genes, and even after the Human Genome Project is completed, all we'll know is the sequence of these genes. We won't know what they do in the body, at what stage in our life cycle the gene is expressed, or how one gene interacts with others. The total amount of information contained in the human genome is truly overwhelming. Comparing that knowledge to an ocean, all we're doing is scooping water out of a tiny lagoon. And with each scoop, the inlet fills up with more water. The idea of creating a new species of human anytime in the next century is about as like-

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JUL91ON5

ly as traveling at warp speed to a galaxy millions of light-years away.

Omni: If ninety-eight percent of our DNA matches the chimpanzee's, perhaps you'd have to change only a few genes to transform the species.

Anderson: That's misleading. That figure is based on how much of our DNA will bind to, or "hybridize," with a complementary strand of DNA from a chimp. If you actually look at the bases [the basic components of the genetic code], only about seventy percent of our DNA exactly matches the sequence of a chimp. We probably differ by twenty to eighty million base pairs. That's an enormous difference when you consider that gene therapy usually involves the correction of only one or two genes, or what amounts to a few thousand base pairs.

Omni: Still, by introducing extra copies of those genes that possibly encode for enzymes that repair damage done to DNA as we age, couldn't we, say, double our life spans?

Anderson: You're not talking about creating a new species now. The scenario you're presenting is more than possible—it very well may happen over the next hundred years.

Omni: Would it be ethical to alter our genetic endowment to live one hundred and fifty years?

Anderson: No, because society isn't ready to handle the problems that this development would engender. As it is, we can barely care properly for people living into their eighties or nineties. Also, a gene that expands our life span may have twenty other detrimental effects. These individuals may live longer—but might be worse off in terms of their vigor, health, intelligence, memory, and so on. Say, parents of short children might want their offspring to receive the gene for human growth hormone so they could become basketball stars. But who knows what problems that might cause later in life?

Let's say, however, that our knowledge progresses to the point that we can safely expand the human life span or make kids taller, or who knows. Maybe someone will discover a gene coding for a neurochemical that enhances memory. Then there's the whole issue of equality. Who gets the gene? Who decides who qualifies? And by what criteria? Do we give the memory-booster gene to mentally retarded children, because they need it the most? Do we give it to smart kids, who could make the most use of it? Who deserves to live longer? Be taller? Our society has no answers. I don't think we should use a powerful technology just because it exists.

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Omni: Once the technology exists, won't there always be genetic doctors who'll perform surgery for the right fee?
Anderson: Yes, based on what we know is a thriving black market for steroids among athletes
Omni: We have cosmetic surgery, and a system for deciding who gets it—namely money. Why is this different?
Anderson: It's considerably more fundamental, something that strikes at the core of who we are. Surgery on the breasts or face is very superficial in the real sense of the word. Why doesn't society permit Olympic athletes to take steroids if what we want is people who can jump higher, run faster, lift more weights? The reason is only partly because of the dangerous long-term health consequences. Steroids give people an unfair advantage
Omni: What could be more unfair than our genetic endowment at birth?
Anderson: True. And society quite legitimately is concerned that the richest, most powerful, most famous, will get the good genes first. Elite groups could become even smarter, better looking and richer than people disadvantaged from day one. That's why society is more comfortable with the idea of offering genetic surgery to individuals who, through no fault of their own, suffer from severe diseases. Then it is morally justifiable to at least try to bring them up to a minimum level of quality of life. To take an acceptable quality of life and try to enhance it would be more disruptive to society than beneficial
Omni: Would it be ethical if we could boost everyone's intelligence or life span or physical prowess through gene transfer?
Anderson: Yes. If it turned out everyone could have a marvelous quality of life for one hundred and fifty years, then everybody ought to have it. But now we're getting into the argument of how many angels can stand on the head of a pin—because for the next fifty years it's not going to be possible to genetically engineer the whole population
Omni: How do you decide what constitutes a disease? How short is too short? How fat is too fat?
Anderson: You start out with severe cases: the child who'd grow up to be under three feet tall. If the procedure proves safe and effective, then you would gradually extend treatment to people with less serious conditions. Until gene therapy is well accepted by society, we should err on the side of being too conservative and restrict treatment to the most medically needy
Omni: Might a future generation view gene therapy like cosmetic surgery?
Anderson: If we continue to destroy our ozone layer and pollute the environment with toxins and carcinogens, everybody may need gene therapy in another thousand years—extra genes for DNA repair enzymes to protect against harmful radiation from the sun, extra genes to boost the number of liver enzymes that can detoxify dangerous compounds. A *New Yorker* cartoon shows a spokesman outside a nuclear reactor saying to a TV crew, "Not to worry. The genetic damage caused by the nuclear accident can be corrected by genetic engineering." I hope *that* day never comes to pass, but one cannot be encouraged by how we're handling our environment now. What happens with gene therapy in the long run depends on the risk–benefit ratio to society. But what society does five hundred years from now is not for us to decide. They wouldn't care what we have to say any more than we care what people in 1600 thought about how we should spend our lives. Ethics, after all, is contextual. To a future society, gene therapy may not only be acceptable—it may be essential for its survival

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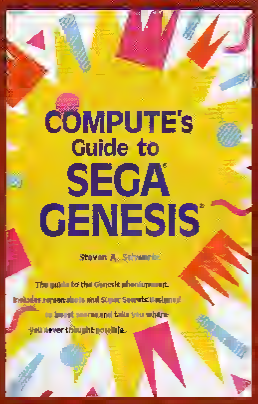

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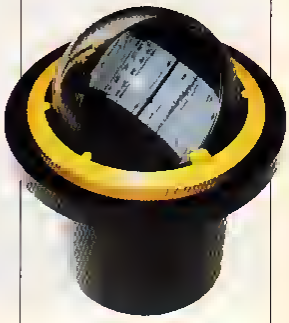

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VIDEO GAMES

HARDWARE WARS

Nintendo may be the superpower, but competition's on the horizon

Anyone who still needs proof that interactive entertainment has reached mass-market proportions should watch for the new game systems hitting stores this fall. It will be the most intense competition in video game history.

Picking up the banner from the veteran Nintendo Entertainment System, Nintendo's 16-bit SFX is the bruiser to beat in the hardware wars with improved animation, more color, more action and most of all, extraordinary music and sound effects. To make consumers bite, Nintendo is baiting the 16-bit SFX with the fourth game in its incredibly successful *Mario Brothers* series. *Super Mario World* is the best *Mario* yet, with eight worlds and 70 levels in a four-megabit cartridge. The SFX's most potent challenger, Sega's 16-bit Genesis, is hitting its audiovisual maturity. New Genesis triumphs—like the action-filled but nonviolent *Mickey Mouse Castle of Illusion* and *Sword of Vermilion*, a graphically outstanding role-playing game—are among the best video games available. A hot group of upcoming Sega releases includes a lavishly illustrated game based on Walt Disney's *Fantasia* and a quirky action game featuring the unlikely character of Sonic the Hedgehog. It will be some time before SFX titles can match the polish and flair of the latest Genesis winners.

The third-place contender seems to be NEC's TurboGrafx-16. For arcade action games, the 8- and 16-bit TurboGrafx surpassed Genesis throughout 1990. But improvements in Genesis programming have blunted TurboGrafx's lead in swift animation and arcade challenge. TurboGrafx, however, still carries a punch with its large and varied game library, as well as the only CD-ROM player yet available for a video game system, planting it securely in the multimedia future of interactive entertainment. The growing number of TurboGrafx CDs includes the run-and-shoot variety of *Valis II*. One upcoming NEC CD features an interactive Sherlock Holmes mystery using real actors, spoken dialogue, and true whodunit deduction. Other forthcoming CDs include *Wanderers of Ys*, the sequel to *Omni*'s 1990 choice for best role-playing game, and educational games such as *Magical Dinosaur Tour*.

SNK's Neo-Geo offers arcade quality games that are literally clones of their quarter-gobbler arcade versions. The challenge of Neo-Geo, however, goes beyond your joystick and deep into your wallet, selling for more than $600, with a single game and new game cartridges costing nearly $200.

The hardware wars will also mount a battle royal in your hand as several portable game systems punch it out. Game Boy still rules the marketplace with a sizable catalog of games and its less-than-$100 price tag. But the competition hopes that players will grow impatient with Game Boy's dim, hard-to-see black-and-white screen display and variable-quality games. A recent cartridge blitz from Atari, for example, has given Lynx owners a hefty choice of excellent games. (Check out the arcade authenticity of *Rygar* and the addictive puzzlement of Tengen's *Trax*, another *Omni* winner for 1990.) At the Winter Consumer Electronics Show, Atari also promised a redesigned Lynx with smaller proportions and a cost of less than $100.

At the high end of the spectrum, the NEC TurboExpress holds court as the Porsche of hand-held games. The NEC portable still has the brightest, most eye-pleasing color screen display and, since it uses the same cartridges as the full-size TurboGrafx, the best portable games. But those boasts are diluted by the price of nearly $250.

This summer Sega is scheduled to introduce Game Gear, costing less than $130. This portable system uses a color screen display similar to that of the Lynx but will also offer the TV tuner option (which converts the game system into a portable TV receiver) previously available only to TurboExpress owners. The shortcoming: Game Gear requires its own cartridges and is not compatible with either the Sega Genesis or the Sega Master System. Never before have so many viable game systems gone head to head for the hearts and hands of players. It's going to be a tremendous fall season for the choosy gamer, and an expensive one for those of us who want it all.

—BOB LINDSTROM

GAMES

PARTY PUZZLERS

A convention of unconventional brain teasers

By Scot Morris

You may have a Rubik's Cube or two collecting dust in the closet, perhaps alongside a Pyraminx or a wooden barrel that comes apart into a dozen pieces. But they won't get you an invitation to the Puzzle Collectors' Party, where people with only 500 puzzles might call themselves "small" collectors. (Jerry Slocum, the party's organizer and host, owns more than 17,500.) Guests have presented not only selections from antique puzzle collections, but also such new puzzles as the Moody Ball, Oskar's Cube, and Puzzlecal.

During the three-day party, guests shared their love of games, thriving on the complexity, discovery, and surprise found in puzzles, illusions, and magic. These collectors value mechanical puzzles, the kind you manipulate with your hands and solve through reasoning, insight, luck, and dexterity. For example, the object of Escape from Alcatraz, Edward Hodern's diabolical ball-in-cage, is to remove a steel ball from a tiny wooden cell that has only six bars.

Sometimes you simply have to use your head to figure out "impossible objects" that seem to defy explanation, like Nob Yoshigahara's wooden arrow through a Chinese coin, or Harry Eng's tennis shoe in a cider bottle, or the Toyo Glass Company's one-of-a-kind 22-pound slab of granite with a wooden arrow through its middle.

The puzzle party presents the perfect opportunity to showcase ideas that haven't yet made it to the American market. Gerd Braun, for example, came from Germany with a spherical puzzle he calls the Moody Ball. In a twist on an idea that came from Hong Kong last year, the Moody Ball has 12 frowning faces. The object: Twist the segmented ball and find the one position—out of more than 100 million possibilities, in which all faces are smiling.

Oskar's Cube came from Oskar van Deventer of the Netherlands. Here a maze is cut into each side of a hollow black plastic cube. A crossbeam inside has six arms, with one arm protruding through each of the mazes. The object: Manipulate the crossbeam arms through the mazes and visualize the invisible three-dimensional path the crossbeam's center must follow. The task actually requires you to simultaneously solve three mazes.

From Tokyo Puzzlecal is a remarkable calculator with a keypad of multicolored squares. After performing a simple division problem on the calculator, inventor Yoshiyuki Kotani told me to look at the instructions on the bottom. When I turned the calculator over, all the keys fell out. Although Kotani replaced them *in random order*, the calculator still worked. It turns out that the back side of each key is encoded so that no matter where it's placed, the 4, for example, still works as a 4 and the + still functions as a +. When the 9 is inserted upside down, however, it registers as a 6, and when the 1 is turned on its side it becomes a minus sign.

In addition to its granite slab, Toyo's impossible puzzles include the Arrow-through-bottle, which resembles the bottle showcased in the April 1984 Games column. But the hole through the center of Toyo's bottle is a sealed tube so the bottle still holds liquid without leaking.

After disassembling and reassembling complicated objects, however, some of the most lasting memories involve simple things like a Cheshire cat coffee mug that Tom Rodgers of Atlanta gave me. Fill it with hot liquid and the blue cat disappears, leaving only its red smile. Or the name *Peggy Babcock*, a surprisingly difficult tongue twister from Mark Setteducati of New York.

Attendance at the Puzzle Collectors' Party is by invitation only, and a record-breaking 150 puzzle collectors arrived for this year's party. If you think your collection might qualify you for an invitation, contact Jerry Slocum, Box 1635, Beverly Hills, CA 90213.

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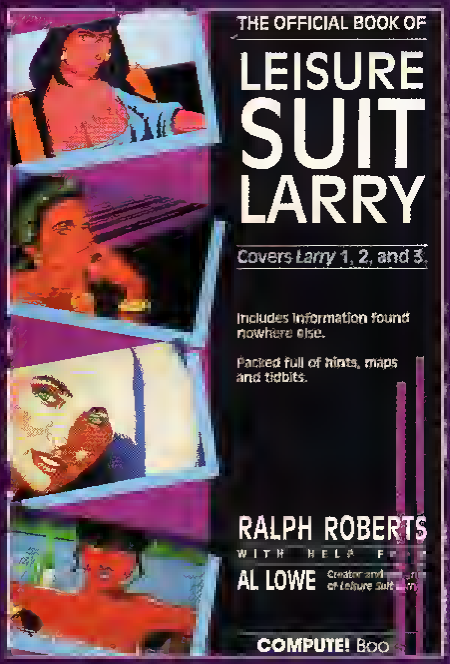

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LAST WORD

MAKING WAVES

Radio signals wreak havoc on an unsuspecting public

By Stan Sinberg

Ask a creative person like Robin Williams or Isaac Asimov, "Where do you get your ideas?" and he almost always replies, "I don't know" or "From everywhere" or something equally vague. Although this is an intelligent answer—after all, why should he tell you?—it's not the truth.

I'm going to tell you the truth. Not only do I know the source of ideas, but I can tell you where almost *all* thoughts originate. Not only thoughts either, but also why sometimes when you are walking down the street you suddenly find yourself humming some old song you haven't thought about for years and may not even like. Even worse, you can't get it out of your mind.

Inventing, say, a new cheese and humming a Barry Manilow song might seem like pretty different phenomena, but they both come from the same place: renegade radio waves.

Scientists have been telling us for years that radio waves don't disappear, they just keep drifting off into outer space until they come in contact with another civilization. This has always been considered positive because it ensures that singers like Janet Jackson will still be stars 10 million years from now, although perhaps in another galaxy.

But because of factors like tall skyscrapers and pollution, a fair amount of radio waves are trapped here on Earth, just floating around the atmosphere waiting to be picked up by unsuspecting passersby. Radio waves enter through your ears, hook up to your "idea center," and the next thing you know, you're thinking the thought.

The logjam of renegade radio waves explains a lot of things. Why do two people often invent the same gadget or come up with the same joke simultaneously? Because the idea for the invention is floating around some cigar store until two inventor types tune in to it.

People walking around the city talking to themselves aren't crazy, as you might suspect. Rather, they're walking radio receivers. That's why they'll carry on an animated conversation with themselves one minute and break into song the next.

Speaking of songs, the tune "Doo Wah Diddy" is legendary for floating around street corners waiting to leap into innocent minds and compel people to sing. Haven't you ever wondered why almost everybody has hummed it, even though most people think it's an asinine tune?

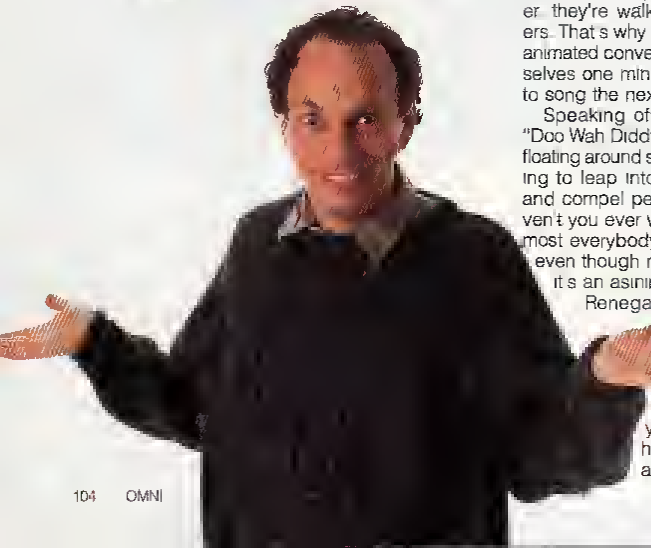
Renegade radio waves even solve one of the biggest mysteries of recent years: what the heck the guys who attacked Dan Rather meant when they said, "Kenneth, what is the frequency?" They were trying to tune in to Dan's brain waves so that they could send messages directly to him while he was reading the news, forcing him to alter his broadcast and thus influence America's thinking on an issue. Pretty insidious, indeed. Fortunately for us, Dan fought them off.

People in big cities seem to get many more ideas than folks in, say, Nebraska, because places like New York are beset with constant barrages of renegade radio waves. Sometimes innocent bystanders are hit by two very different waves at the same time, causing people in New York to get weird ideas like charging $20 for a plate of spaghetti, which is okay if you call it pasta.

People out in the boonies however, have to sit around a long time before they're hit with inspiration—that is, a random radio wave—and then it might be something like The Archies singing "Sugar, Sugar." That's why most creative people move to cities, although they don't know it.

Psychiatrists have suspected this business about floating radio waves for a long time. That's the main reason most of them stopped having their patients free-associate. A recent study found that rather than tapping into their subconscious, many patients were merely picking up the ideas of the person who was previously in the room.

As a writer, I've trained my mind to be empty most of the time, in order to receive stray ideas. When one strikes, I immediately stop whatever I'm doing (usually nothing) and do a piece about it, before another writer on the same frequency picks it up and accuses me of getting the idea from him. Which, come to think of it, maybe I did. ∞



Stan Sinberg walks around with a satellite dish to make sure he receives weird ideas from outer space