OMNI

JANUARY 1990

MEMO
TO: THE PRESIDENT
FROM: G. GORDON LIDDY
SUBJECT: NEAR FUTURE POTENTIAL FOR MASSIVE TERRORISM ON U.S. SOIL

HIGH-TECH RESCUE OF ENDANGERED SPECIES

RAY BRADBURY, ISAAC ASIMOV, ROBIN COOK, ET AL. PREDICT THE WORLD OF 1999

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VOL. 11 NO. 4 JANUARY 1989

CONTENTS

The earth's welfare rests on the survival of all species. The Bear, an oil painting by Spanish artist Gervasio Gallardo, depicts the integral relationship between one of the world's wildest creatures and its environment

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IN 1876, GEORGE CUSTER HAD A FREE DEMONSTRATION OF WHAT SURROUND SOUND WOULD BE LIKE IN 1989.

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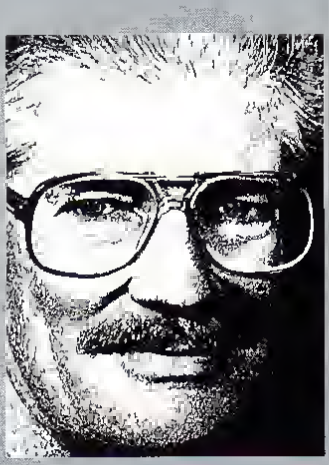

FIRST WORD

By Herman E. Daly

"Steady-state economics will allow us to mold our future in accordance with our goals—a future filled with prosperity, productivity, and enough resources to meet our world's needs."

The modern world functions in a state of continuous "growthamania." Growth is credited as the cure for poverty, unemployment, debt repayment, inflation, pollution, divorce, the population explosion, and drug addiction and is ultimately considered the panacea for the world's ills. In fact, the cornerstone of this country's current economic strategy is "rapid growth." In this closed system infinite raw materials are supposed to flow freely to an infinite sink—a world that exists without limitation.

The biophysical environment is absent from this standard economic theory and practice. Economists fail to consider availability of raw materials or the environment's ability to sustain or absorb large quantities of waste. As the economy grows, the ecosystem is under constant assault. Our resources (provided by the earth) are rapidly disappearing, and we are running out of places to discard our waste.

Rapid-growth economists believe that limiting growth is unnecessary. They argue that the human mind is the ultimate resource and that through new technology the mind can stimulate endless growth. New knowledge will remove old limits on growth faster than new limits are established.

This theory is like a species of animal that has only a circulatory system and no digestive tract. These animals could neither eat nor defecate. They are perpetual motion machines, independent of the sources and sinks of the environment. The economy, however, like a real animal, has a digestive tract that ties it to its environment at both ends.

Current economic policy focuses on short-term gain, often at the expense of the long term and ultimately at the expense of our future. A recent census revealed that duck hunting in the Eastern states has reduced the Canada goose population, which migrates through this area, to half its normal size. As a result the hunting season was curtailed. Residents of towns that depend on the visiting hunters for a major percentage of their income were outraged.

Influenced by current economic trends, these people are focusing on short-term gain. They aren't looking to the future. If hunting isn't temporarily reduced, eventually there won't be a single goose left to hunt. Resources are not unlimited. To maintain an economic future, it is necessary to sometimes set restraints to allow a resource to replenish. Then the future of the economy can be controlled and stabilized.

Technology needs to be used not to continue growth but to find ways to get more out of the same territory. We need to develop a capacity to share as a community, and individually give up luxuries. In a community some will still have more, and others will still have less, but no one will have a right to luxury if anyone is lacking necessities. And the escalating human population must be slowed and then reduced.

I believe that the world's human civilization can no longer be sustained under current economic trends. "Steady state" economics needs to be reestablished throughout the world because the economy is becoming too large for the ecosystem to support.

Economists don't deny that resources come from the environment and that waste returns to the ecosystem. When current economic theory was developed, however, the environment seemed to be an infinite source in comparison with the size of the economy at the time. Today the economy has outgrown the capacity of the earth.

Steady-state economics, on the other hand, is closer to the way man has lived throughout the ages. A steady-state economy includes the ecosystem within the cycles of production and consumption and maintains a state of equilibrium with the environment. Births replace deaths, production replaces depreciation, and the economy remains fixed—input and output are equal—while the quality of life is continuously improved. In a steady-state library when a new book is added to the shelves, an old book must be removed. A new book is added only if it is better than the book it is replacing. The quality of the steady state library will continue to improve, but the size of the collection of books will remain constant, just like a steady-state economy.

Steady-state economics will allow us to mold our future in accordance with our goals. If we base the future of the world economy on the resource depletion and population explosion of the last three decades, then the future looks bleak. If we try to plan the future based on what we know about how the earth works and what we intend to accomplish, then the future has a great deal to offer.

The accelerating devastation of the natural world in the name of economic growth makes the switch to steady-state economics a very urgent issue. We are gambling with the future and ignoring the needs of the next generations if we continue to follow current economic trends. Steady-state economics will allow us to choose a future filled with prosperity, productivity, and enough resources to meet all our needs. ☐

Herman E. Daly, an economist in Washington, DC, is the author of Steady State Economics *(W. H. Freeman and Company).*

CONTRIBUTORS

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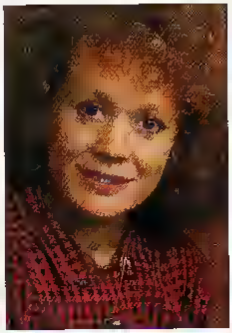


SPENCER

LIDDY

GULAG

DREXLER

GARDEN OF EARTHY DELIGHTS

DATELINE 1999

Go forth to meet the shadowy Future, without fear, and with a manly heart.
—Henry Wadsworth Longfellow

The words above could easily have been inscribed on the hearts and minds of all those contributing to the first issue of the new year (if you deleted the word *manly*, that is). Everyone from SF maven *Ray Bradbury* to Watergate burgler *G. Gordon Liddy* to our Washington editor *Cathy Spencer* gazed into their respective crystal balls and described, courageously, visions of tomorrow.

By assessing advances made toward preserving endangered species, Spencer predicts a time in the not-too-distant future when humankind will uphold the rights of all species. In "Ark de Triomphe" (page 48) Spencer marks the accomplishments of the individuals involved in protecting vanishing species.

In the process Spencer almost became an endangered species herself—her legwork in Yellowstone National Park left her nearly face-to-face with a buffalo bull. "Maybe two hundred buffalo had just finished crossing a stream a few hundred yards from me. One stopped dead in his tracks and looked my way," she recalls. "That was enough for me to turn on my heels and walk back down the trail."

It was the universal hope that the future be devoid of war that led associate editor Tom Dworetzky to contact *G. Gordon Liddy* concerning the future of terrorism. "Sometimes the best way to prevent something from happening is by admitting that it could happen and by working out all possible scenarios," Dworetzky explains. And who better to write about that ultimate scenario than Liddy, once involved in a Miami-based security company that boasted an antiterrorist squad capable of rescuing kidnapped executives (see "Rules of the Game," page 42)?

Liddy initially expressed some hesitation about the project, given that his two sons are members of America's elite combat forces and deal with plenty of classified material. Readers might mistakenly assume that the information came from them. "He pointed out that all of the material needed to describe a future attack by terrorists was in literature available to the public," Dworetzky adds. Liddy agreed to write the piece with the stipulation that he would not be expected to reveal anything classified.

Molecular engineer Eric Drexler (Interview, page 66) foresees a future in which miniature machines can repair the body—from the inside out. *Omni* writer *Ed Regis* (*From Einstein to Frankenstein*, Addison-Wesley) explains, "Nanomachines—tiny robots called assemblers—will be smaller than living cells, smaller even than some viruses." Artificial intelligence guru Marvin Minsky has predicted that nanotechnology will have more effect on our existence than the "harnessing of electricity" did.

Rich in possibilities, nanotechnology provides fiction writers with fodder for their stories. They will be among the first to "use" Drexler's microscopic devices. *Edward Bryant* asked *Robin Cook*, *Isaac Asimov*, and others to think about setting a story in the year 1999. "They used the 'what if' approach," says associate editor Kevin McKinney. "What would happen, for example, if nanotechnology were available?" "Dateline 1999" (Forum, page 22) lists their predictions.

Senior editor *Jane Bosveld* allowed the same sense of wonder that propels many science-fiction greats to inspire her essay called "Wonderlust" (Continuum, page 33). Among those things she numbers most wonderful are the humblest of critters—*bugs*. As a child Bosveld spent hours collecting insects, which she carefully pinned to large Styrofoam blocks. Among her proudest specimens: the neighborhood's largest bumblebee. In "Garden of Earthy Delights" (page 60), Bosveld waxes lyrical on the merits of foreign species.

Featured in our special section is *Gregg Keizer*'s novelette *The Gulag on the Rue des Grandes Augustins* (page 96). "The most difficult part of writing the story," Keizer confesses, "was creating a sense of reality within the framework of illusion." His vision of Paris is likely to deter even the most devoted Francophile from visiting. ☐

LETTERS

COMMUNICATIONS

Eye of the Beholder

Christopher Lasch's essay ["The Last Freak Show," October 1988] addressed feelings that have been heavy on my heart for some time that we "normal" people are the truly handicapped. Our inability to acknowledge or accept human abnormalities is an indictment of our own shallow integrity and our inability to love one another unconditionally. We must remember we are all the same under our skin. We bleed, cry, ache, have hopes, dreams, and fears. We're all looking at life through the same eyes. But while we are looking from the outside in, they are looking from the inside out.

Sabrina Fair Thomas
Los Angeles

Rain Forest Rx

I enjoyed your article "Amazon Apothecary" [Earth, October 1988] about the search for anticancer plants in the Amazon. The article properly focused concern on the deforestation of the Amazonian jungle. In addition to the possible loss of medicinal plants, the clearing and farming of the rain forests threaten to destroy many other plants and animals. I hope ways can be found to slow the destruction of these areas and the diverse species they contain.

Greg Thomas
Orange Park, Florida

Heavy Soles

I would like to correct an error in "Lee County's Lizard Man and Other Unsolved Mysteries" [October 1988], which cited my research on alleged human and dinosaur tracks in a Texas riverbed. The article stated that I eventually identified the human tracks as "dinosaur toe prints." Actually, as early as 1970 a team of researchers from Loma Linda University in California demonstrated conclusively that the alleged "man tracks" were elongate dinosaur tracks, but their work was initially neglected because they failed to explain why. One of the contributions of my research was to demonstrate why the tracks were elongate—that some bipedal dinosaurs evidently impressed their soles and heels in the ground as they walked, rather than walking on their toes only.

Glen J. Kuban
North Royalton, Ohio

Are Two Heads Better Than One?

I have recently finished reading "Double Takes" [October 1988] and found the article very interesting but for the wrong reasons. It scared me. All these proposed benefits to cloning mankind sound great; however, the possibilities of the monstrosities it could create chill my blood. I'm all for scientific advances that would ease human suffering, but it seems to me that some of these "mini-Frankensteins" would be trying to outsmart nature, and that can end only one way.

Marlene Calnet
Miami

Catatonic

I just finished building the *Omni* photovore (the "robot that thinks like a roach") [October 1988] and promptly sent it scuttling off around my apartment. I live alone with my cat, Ramtha, and therein lies the problem. Maybe it's simply jealousy, but since the photovore joined our little family, Ramtha has been completely irrational. She stalks the 'vore everywhere it goes, ambushing it, pouncing on it, and once, I suspect, pushing a coffee cup off a counter to try to hit it from above. She seems to have lost much of her former enthusiasm for food and is sleeping less. I know there are pet psychiatrists, but before I make an appointment, I would like to know if *Omni* could split the cost with me for Ramtha's treatment. After all, it's your robot that caused this.

Tom Rose
Indianapolis

Statistical Error

Responses to the December 1988 "Altered Stats" questionnaire should be sent to OMNI-ASC, 1965 Broadway, New York, NY 10023-5965. ◘◘

DATELINE 1999

FORUM

By Edward Bryant

During a panel discussion at a science-fiction convention, someone in the audience asked, "What can we expect during the next century?" Upon hearing the question, writer Bruce Sterling leapt up and exclaimed, "You're all gonna die!" While not particularly scientific in its orientation, his declaration demonstrates science fiction's great predilection for shaking its readers awake and reminding them that, in the words of French philosopher and essayist Paul Valéry, the future isn't what it used to be.

Science fiction has always depended to a large degree on the shotgun approach to extrapolation. Fire enough predictions in the general direction of tomorrow and those few that strike true will be the ones best remembered. Never mind the 99 percent that end up as dated and as dead as last year's headlines in the *Weekly World News*. Writers of imaginative literature have usually fared better in projecting trends in technology and society than in making specific predictions.

H. G. Wells, for example, didn't go into great detail about the gravity-shielding material "Cavorite" that made his lunar expeditions possible in *First Men in the Moon* (written in 1901), and the biological experimenter in *The Island of Dr. Moreau* used surgical steel rather than DNA splicing to create his animal–human hybrids. The exploration of the nature of good and evil in *Dr. Moreau*, after all, is ultimately more engrossing and more important than whether the hubris-laden doctor was tinkering chromosomes.

Did Wells's French counterpart, Jules Verne, invent the submarine with the creation of the *Nautilus* in the 1870 novel *Twenty Thousand Leagues Under the Sea*? Nope. Captain Nemo's pride and joy was just more sophisticated than the underwater craft that already existed. And in *From the Earth to the Moon*, was it simply luck that Verne set the location for his successful lunar launch near that of the present-day Kennedy Space Center? Probably.

All this is not to say that the roll call of science fiction's accurate forecasts is not formidable. The list ranges from Wells's predictions of tank warfare and aerial bombings to Robert Heinlein's remote controllers. As automation has advanced in the real world, Heinlein's devices have proliferated—and they're still called waldoes, named after the Heinlein character who invented them. In his book *The Roads Must Roll*, Heinlein also described moving roadways, a complex marvel of mass transit pretty much limited in the real world to today's air terminal concourses.

So will antigravity, hyperspace, ansibles, teleportation, spindizzies, positronic robots, and warp drive become reality? Will they join radar, atom bombs, and electric can openers in a future accurately—if sometimes accidentally—predicted by science fiction? Some, of course, will.

As a wise writer once observed, the importance of science fiction is not that it predicted the advent of the motorcar but that it foresaw the traffic jam. We've managed, however, to coax a number of science-fiction writers to focus on the last days of the 1990's. What discoveries or developments, we asked them, might occur between now and December 31, 1999? Some earlier authors' scenarios and the later realities round out the roster.

Science fiction predicted waldos, radar, and bombs. How long before we see robots like these?

Robin Cook, *author of* Coma, Mortal Fear *(Berkley), and* Mutation *(Putnam)*

Although we're going to see dramatic improvements in transplantation during the next ten or 15 years, genetic manipulation is going to make organ transplants seem terribly old-fashioned. It will also cause most of modern medicine, perhaps even doctors, to become obsolete. The real physicians, in fact, will likely be genetic engineers.

I also believe that viruses are going to be useful in the genetic-engineering revolution. We're going to see a change in our perception of viruses. We'll no longer view them as some sort of inimical enemy. They may be much more helpful than we realize.

CONTINUED ON PAGE 82

NASA'S NEXT GENERATION

SPACE

By Alcestis R Oberg

Wanted pilots and engineers preferably with military or NASA background Must be team players able to perform tedious tasks with meticulous precision

If you spotted this want ad in your favorite aerospace magazine you'd think it was for some standard tech job designing widgets—not a classified advertisement for NASA astronauts The stereotypical Sixties astronaut was a superhero type late in the Seventies a new model was introduced—scientific whiz kids But in recent years the astronaut selection boards have started looking for a new breed of space explorers cooperative well-rounded government workers who don't seek to achieve star status Indeed of the 28 astronauts hired between 1985 and 1987 only two (both women) came from outside NASA or the military

Today's model astronauts are different from their predecessors In the early days of the space program the greatest character trait required of space pioneers was bravery Inside that capsule their main tasks were to survive and probe the unknown

With the advent of the shuttle era, the emphasis on individual resourcefulness and creativity shifted The most prized qualities for astronauts became detail-oriented precision and teamwork—essential traits for performing delicate, though routine, experiments "Everything now takes a team of specialists" says former astronaut Terry Hart "It's as though our technology is rising above the cerebral powers of the individual"

The hopefuls fall into two astronaut categories pilots and mission specialists The qualifications for spacecraft pilots haven't changed much in a decade Candidates must have thousands of hours flying high-performance military planes—not commercial aircraft To gain an edge, some pilots have even sought to improve their visibility by taking jobs in NASA Aircraft Operations, the branch that manages NASA research and support planes These days, however, NASA management seems to have ceased to regard this branch of the agency as a "holding pen" for future shuttle fliers One other shift that may also have an impact on the temperaments of those who become astronauts Since *Challenger*, more astronauts have rotated through NASA management assignments

Mission specialists—the people who carry out shuttle "tasks"—do not actually fly the orbiter, but most have a pilot's license at least, and many possess jet aircraft experience Their main job is to manage payloads, run experiments perform spacewalks work the orbiter's remote arm, and act as flight engineers during launch and reentry A typical academic background for a mission specialist would include a graduate degree (more often a master's rather than a Ph D these days) in engineering, math, or some science, along with several years of hands-on technical experience in the aerospace field

If a candidate really wants to make the grade, though the place to go is the Johnson Space Center in Houston, which has turned into an unofficial space academy The center assumed this role starting in 1978, when NASA found itself awash with nearly 10,000 hopefuls seeking a spaceflight career during the shuttle era Some individuals who had been passed over for immediate selection were invited by the agency to take jobs in space operations in the Houston complex and await a chance to make it into a future class This gave civilian candidates a chance for space operations experience while managers could see how they handled the tedious, not-so-glamorous world of developing spaceflight hardware and procedures "Your chances of becoming an astronaut are improved" says astronaut Norm Thagard "insofar as you're a known quantity" Some have gone far to gain greater visibility The Johnson Space Center baseball leagues became bloated with players when astronaut candidates found out that former Chief of Flight Operations George Abbey was a baseball fanatic

Such unofficial practices have led to

CONTINUED ON PAGE 80

Getting into the astronaut corps Is it the right stuff or the right place at the right time?

POTLUCK

EXPLORATIONS

By Douglas Preston

The scene was like something from an Arthur Conan Doyle novel. The evening was drawing to a close as the fire, having died to just embers, cast a reddish glow on the walls. Outside, a coyote began howling. Archaeologist Tim Maxwell rolled his brandy around in a snifter and gazed into it. We were discussing his excavations of Indian ruins near Abiquiu, north of Santa Fe, New Mexico.

"If you promise not to reveal the location, I'll tell you how to find what I think is the most incredible ruin in all of New Mexico," he said. "It's called Tsiping, which in the Tewa language means *House of Flaking Stone Mountain*, and very few people know it exists." He then mapped directions to the pueblo, complete with landmarks. But even with this, he added, Tsiping would be difficult to find.

Some weeks later, a friend and I set out from Santa Fe for Tsiping. Following the directions on the map, we made our way into one of the lush valleys that snake through the wrinkled mass of the Jemez Mountains. The road quickly turned to dirt, deep ruts, and boulders, and eventually became a faint trail.

When we finally found the 800-foot-high mesa, the trail slithered up a split in the rock and spilled out on top. There the vast ruin of Tsiping, skirting the edge of the cliffs, floated above the desert like an island in the sea.

Tsiping, or more completely, Tsipin-guinge, is just one of the hundreds of large pueblos constructed in northern New Mexico by the ancestors of the Hopi, Zuni, and other Southwestern Native American tribes. In Chama Valley alone, archaeologists have identified the remains of at least 21 ancient structures, some consisting of more than 2,000 rooms. They are, of course, on public lands under the jurisdiction of the U.S. Department of Agriculture's (USDA) Forest Service, but are accessible only to whoever can find them. The Forest Service's computerized inventory of the sites has not been made available to the public. The fewer people who know how to find Tsiping and other pueblos, officials believe, the better the ruins' protection against looters.

Constructed of chiseled blocks of tuff, a fine volcanic material, Tsiping was a great pueblo more than 600 years ago. Like most Southwestern pueblos, it was built as a fortress, with open plazas surrounded by three- and four-story clusters of tiny rooms. The once-massive outer walls now resemble the crumbling ramparts of a medieval castle.

Exploring Tsiping's plazas, my friend and I found a dozen kivas—circular, subterranean ceremonial chambers probably used by medicine and other tribal societies. We discovered other features, too: a reservoir to catch water during storms; petroglyphs carved or inscribed in stone; and a stairway cut in the rock. There was also a structure that, we later learned, had been an observatory to track the seasonal movements of the sun.

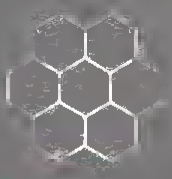
Tsiping has never been excavated to unearth its treasures. The surface and structure weren't even surveyed until 1979, when Forest Service archaeologists Landon Smith and Julia Dougherty spent three days there. About 25 percent of Tsiping had been destroyed by pothunters, grave robbers, looters, and others who look for pots, arrowheads, and anything else that can be sold in the thriving black market for Native American artifacts.

"By virtue of its location, Tsiping is not in as much danger of being looted as other pueblos," said Maxwell, assistant director of the research section of the Laboratory of Anthropology in Santa Fe. "You have to be a pretty dedicated pothunter to hike all the way up there and lug artifacts back down."

More accessible ruins and sites in New Mexico and other states are sometimes completely destroyed by pothunters. Three small stone masonry pueblos, for example, were officially recorded in 1975. By this year, however, one of them had disappeared. Only a few scattered stones remained. "No one knows for sure who carried it away and for what purpose," says culture

Pueblos of the Western World: National treasures for the taking?

CONTINUED ON PAGE 87



CONTINUUM

WONDERLUST

When I was a kid there were two encounters with nature that shook me to the bones. The first happened during a rough nighttime version of hide-and-seek (rough in the sense that the kid who was it had to tackle you to get you out of the game). I had just heard several pairs of feet scuffling through someone's rhubarb patch and took off in the opposite direction past a row of bushes that lined the back of the Second Reformed Church. As I ran, I heard a strange hissing noise and glanced up over my shoulder, where I saw a small fiery ball speeding through the sky about 100 yards away. It was heading in my direction, so I ran after it and dropped to my knees where it landed. The patch of ground was hot, but I could not retrieve anything, not even a small stone that could serve as evidence that a galactic traveler had passed within arm's reach. Where in the universe, I wondered, had it come from?

My second encounter was with a rainbow. A storm had passed through town one steamy summer afternoon and left behind a rainbow which I saw as I was trekking off on some errand. I stopped dead in my tracks when I realized that one end of the rainbow was within running distance. Then I bolted, knowing that if treasure was ever to be found in this world, it would surely be there. Within minutes, I was at the spot where the band of colors entered the ground. There was no gold, but as I stepped into the rainbow I had the feeling that something was going to happen. Nothing tangible occurred, but I remained there for some time, thinking that this was one of the most important things that would ever happen to me.

Perhaps it was. After all, there's really no telling how one or two minutes in a rainbow affects the mind. Maybe it is why I'm stirred by events, ideas, and tidbits of information that leave less romantic sorts untouched. When I read, for instance, that birds can see the stars, I suddenly had images of robins tucked in their nests gazing at Orion. There should, of course, be nothing surprising in this. Birds' sharp eyesight is legendary, but that they might be looking at the night sky had never occurred to me. Similarly, shortly after I purchased my first shortwave radio and slowly turned the knob to tune in broadcasts a world away, I was bowled over to hear a crackling voice announce that I had stumbled onto Radio Beijing. The BBC, Radio Netherlands, even Radio Australia I was prepared for, but China? *How can everyone not own a shortwave radio,* I thought, *not desire this instrument of wonder?*

More people buy microwaves than shortwaves, a fact that leaves me wondering what happened to awe. It is not a moot question. The National Science Foundation (NSF) recently conducted a poll of 2,041 adults in which it asked a variety of basic science questions. The results were sadly revealing. Twenty-one percent of those polled thought that the sun revolved around the earth, seven percent were unsure whether the earth circled the sun or vice versa. When asked if antibiotics kill viruses as well as bacteria, 63 percent of the respondents answered yes. (They don't.) An NSF spokesperson summed up the findings by saying that vast numbers of Americans are "scientifically illiterate."

It's easy to blame this ignorance on an educational system that has failed to teach students the meat and potatoes of science. But the root of the problem goes deeper. Copernicus postulated that the earth revolved around the sun after long hours of observation (his homework), but why did he care in the first place? So the earth circles the sun. Big deal. Copernicus studied because his mind was filled with questions and wonder. Scratch the surface of any scientist and you will find a curious little kid. Indeed, one of the hallmarks of childhood is curiosity, and we must ask ourselves what happens to kids to kill that desire, what nullifies their urge to ask questions or to sit out on a hot August evening peering up at the sky in hopes of seeing a falling star. The right meteorite, the right kid, and you've sprouted another Galileo. To cultivate wonder in a child is to set a galaxy in motion. As Rachel Carson wrote in *The Sense of Wonder,* "If I had my influence with the good fairy who is supposed to preside over the christening of all children, I should ask that her gift to each child in the world be a sense of wonder so indestructible that it would last throughout life as an unfailing antidote against the boredom and disenchantments of later years, the sterile preoccupation with things that are artificial, the alienation from the sources of our strength."

We must learn—for the sake of science, if for no other reason—how to nurture wonder in our children and how to rekindle it in ourselves.—*JANE BOSVELD*

CONTINUUM

It's big! It's fat! It's succulent! And if field tests in Mexico this year pan out, a juicy tomato that tastes like a tomato may be on your grocery shelves in a few years

TOMATO ROYALE

Chances are you haven't eaten a good tomato lately. That's because tomatoes are picked golf-ball-hard to survive shipping and don't contain the palate-pleasing sugars that come only with vine ripening. Enter the "transgenic" tomato.

At Calgene, Inc., in Davis, California, William Hiatt and his team of researchers have figured out a way of turning off the mushiness gene in tomatoes, which is responsible for the soft and juicy (but unshippable) texture of ripe tomatoes. Their process, Hiatt thinks, may make it possible to ripen tomatoes on the vine that are still firm enough to be shipped.

The researchers created their tastier tomatoes by altering the plant's genetic makeup. They first cloned the gene that regulates the softening process and then placed it in the DNA backward. By doing this, the softening gene was deactivated. So far the new breed of tomato has been grown only in greenhouses, and, as Hiatt says, "greenhouse-grown tomatoes are not necessarily representative of real life." The researchers are planning field tests in Mexico this year, which should establish the new tomato's potential. If all goes well, we may be seeing tomatoes that taste like tomatoes on supermarket shelves in about three years.

Once that happens, Calgene researchers are planning to test the same technique on other fruits that bruise easily in shipping and on coffee to see whether a genetically altered decaffeinated version can be grown. —Paul McCarthy

LIQUID SUNGLASSES

With the continuing depletion of the ozone layer and the increasing amount of ultraviolet light that passes through it, protecting the eyes from sunlight is more important than ever. Sunglasses block from 60 to 95 percent of ultraviolet A, light that some ophthalmologists believe may destroy retinal cells and lead to blindness among the elderly, and about 60 to 90 percent of ultraviolet B, which contributes to the formation of cataracts. According to New Jersey ophthalmologist Neville A. Baron, "Even the best sunglasses because of the opening around the frames, leave their wearers at thirty to thirty-five percent risk" for many eye problems blamed on ultraviolet light.

Baron knew there had to be a better way, and after extensive testing he has come up with an alternative—eye drops that successfully screen out up to 98 percent.

Eye drops may be the best protection against ultraviolet light

of ultraviolet light for two to four hours at a time. After four hours, the user simply reapplies the drops. Baron makes his eye drops by combining a gel with a chemical known for its ability to screen ultraviolet rays. The resulting solution does not hamper vision, and so far no one's eyes have been irritated by it. Nevertheless, Baron's liquid sunglasses will have to be approved by the Food and Drug Administration before being marketed.

—George Nobbe

PRESSING MATTERS

What the world really needs is a cool cotton fabric that won't wrinkle and can be produced without using formaldehyde, the secret to today's permanent-press cotton wear. Formaldehyde has been shown to cause cancer in laboratory animals and may soon face government regulation, a possibility that has the textile industry scrambling to find a nontoxic, inexpensive substitute.

The most likely formaldehyde alternative is a process developed by chemists at the U.S. Department of Agriculture (USDA) research facility in New Orleans. Scientists there have discovered that four different groups of alkali metal salts containing phosphorus act as catalysts that bind weak acidic agents to cotton fibers. By soaking fabric in an acid-and-catalyst bath and then quickly heating it to a temperature of 410° F, the researchers were able to bind the acid solution to the cotton, creating a permanent-press fabric.

The only problem is price. The chemicals cost too much for most textile mills to use, but Clark M. Welch of the USDA says refining techniques should bring the price down sometime this year.

—George Nobbe

No more wrinkles, no more formaldehyde

"I figure you have the same chance of winning the lottery whether you play or not."

—Fran Lebowitz

THE QUICKER PICKER-UPPER

Because starting up a diesel engine on cold winter mornings can be next to impossible, a lot of truckers don't even bother. They just keep their rigs running all night, an expensive process that burns out engines and wastes a lot of fuel.

Enter Ioannis Miaoulis, a mechanical engineer at Tufts University, and his graduate student Maureen Selvidge. They revived an old idea and made it work. Their device functions like this: Crystalline salts, which absorb and store heat, are placed in an apparatus attached to a vehicle's engine and collect heat from the exhaust given off when the engine is running. When water is added to the salts, they release their stored heat, warming a cold engine. "You can store the heat one day and use it ten days later," explains Miaoulis.

The researchers have designed a prototype of a crystalline salt converter that is 18 inches long, five inches in diameter, and about ten pounds. All the driver has to do to warm up the engine is press a dashboard button that drops water in the salts. In tests, engines start in only a few minutes.

Although the inventors anticipate no problems designing a functioning version that will easily fit under a truck's hood, they estimate it will take from three to five years to get the finished product to the public.

—George Nobbe

Big [illegible] jump start. How crystalline s[illegible] can get [illegible]ines up and running on cold winter mornings

"A little inaccuracy sometimes saves tons of explanations."

—Saki

CONTINUUM

Read my lips: no more plastic waste. Purdue University researchers may have cracked the problem of biodegradability

PLASTIC EATERS

The trouble with microorganisms is they just don't know when to stop eating. Take the fungi being tested by the biodegrading industry for breaking down plastic food packaging. The molecules in the plastic are too large for the fungi to consume whole, so researchers tried mixing in starch to turn the plastic into tasty bite-size morsels. It worked, but the starch researchers found, weakened the structure of the plastic dramatically and made it particularly sensitive to moisture. The fungi ate their way through and began eating the food.

To prevent the fungi from damaging packaging on supermarket shelves, Ramini Narayan, head of organic and polymer research at Purdue University in West Lafayette, Indiana, started testing other chemicals that might break down plastic molecules without making the plastic susceptible to moisture damage. His research may revolutionize the marketplace. Narayan created a stable plastic that, by substituting cellulose acetate for the starch, didn't begin to break down until it had been thrown away. That's because the cellulose acetate must interact with chemicals in soil before it can break down the plastic into edible parts.

"It's not going to solve everything any more than recycling has by itself," says Narayan. "It's only part of the solution."—George Nobbe

"A vasectomy is never having to say you're sorry."
—Rubin Carson

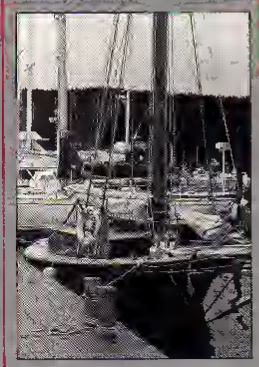
SHRINK-WRAPPED SHIPS

When the Swedes invented shrink wrapping 25 years ago, they probably did not have huge aircraft and towering old sailing ships in mind. But Fana, Inc., of Springfield, Pennsylvania, did when it patented a shrink-wrapping process called Armor Shield film, which is designed to protect large objects during shipping and storage.

The company saw a need to improve on the most common technique now used for "wrapping" large objects—spraying adhesives on the object and later chipping the coating off. Fana uses 32-foot wide sheets of Armor Shield film, which it seals in an airtight covering with a propane-fired heat gun. The shrink wrap can be easily peeled away, as Fana's James Talbot and Anthony Seraphin proved to the Grumman Aerospace people when they wrapped and then unpeeled an A-14 fighter plane in an experiment several years ago.

More recently, they have wrapped a Grumman forward-swept-wing X-29 fighter plane, a three-masted sailing vessel in Philadelphia, the presidential yacht, a host of military helicopters, and untold swimming pools, barns, and storage buildings.

It's the speed and relative ease of shrink wrapping that's boosting Fana's revenues. "We can wrap up an Apache helicopter in four to six hours," says Seraphin. "It takes the military about four days. Three men can take the cover off in fifteen minutes to a half hour, but it takes the military a week to scrape that adhesive gunk off."—George Nobbe



Under wraps. The latest in storage for ships and planes

"How is it that our memory is good enough to retain the least triviality that happens to us, and yet not good enough to recollect how often we have told it to the same person?"
—Duc de La Rochefoucauld

THE DIRTY TRUTH ABOUT TOILETS

Mom was right. You should wash your hands after using a toilet, in fact, it might be a good idea not to use public toilets any more than you have to. A recent study conducted by Charles Gerba, a microbiologist at the University of Arizona, found that toilet flushing spews germs all over the place.

Knowing that feces contain various viruses and bacteria, Gerba was interested in seeing if toilets were being contaminated by the water

Can [illegible] Gerba has tested toilets across the [illegible] and found germs everywhere

sprayed upward during the flushing action He placed dye in a toilet bowl, stretched a lid-high sheet of paper over its top, and then flushed. "We got a dye pattern reaching the toilet seat " he says Then he did postflush time-lapse photography and found that a cloud of spray shoots out of the toilet bowl after each flushing, "just like you see with a sneeze,' he says

His research revealed that the contamination was not limited solely to the toilet seat but also flew outside the toilet, landing on, among other things, the handle used to flush the toilet

"We saw quite a lot of contamination around the toilet rim where it will settle rather quickly " Gerba says And when he placed caged mice in the room and flushed viruses the mice got sick 'Flushing a toilet, ' concludes Gerba "is a particularly good way of spreading viruses' such as the ones that cause hepatitis and diarrhea

Gerba and his colleagues have tested toilets across America by simply walking into a john, washing the toilet with a detergent, swishing the wash into the bowl, and taking a sample of the liquid (Once a suspicious janitor saw Gerba with his head poked into a toilet bowl and called the cops) Back in the lab, the researchers run tests to measure the amount of bacteria in each sample Their results show that gas stations probably have the dirtiest commodes, "because most are not well maintained," says Gerba The cleanest toilets are in hospitals ' probably " says Gerba, 'because they're cleaned the most often " But libraries also have clean toilets He has no idea why As for which stall to go to Avoid the middle one "It's the one most often used," he says —Paul McCarthy

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"Ask not what you can do for your country, for they are liable to tell you "

—Mark Steinbeck

"Millions say the apple fell but Newton was the one to ask why"

—Bernard M Baruch

TEETOTALER CARS

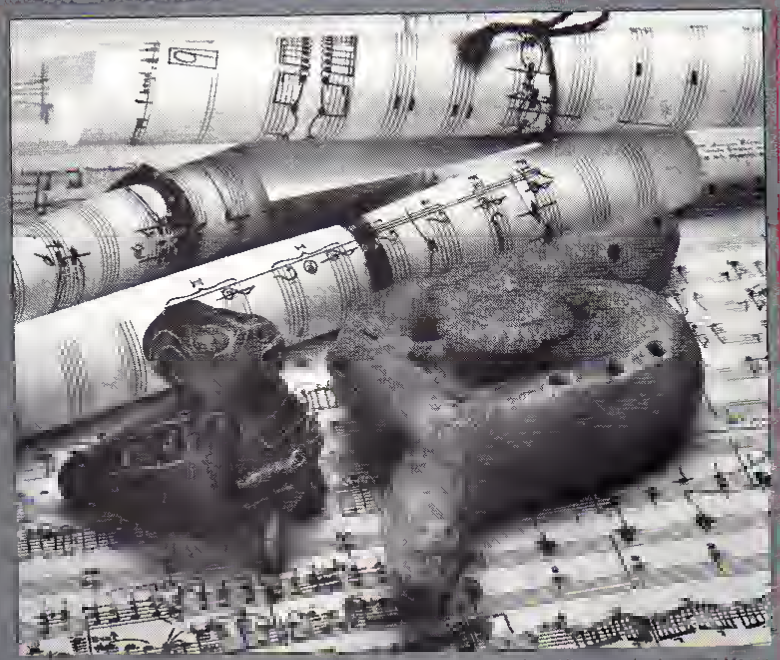
A new electronic device will prevent drunk drivers from turning on their cars Called the Guardian Interlock Ignition System, the instrument links a hand-held breath analyzer to a sensor and microcomputer wired to a car s ignition system To start the car, a driver must first breathe into the analyzer If his or her blood alcohol level is above the legal limit the car won't start.

Already the system has caught on as an instrument of justice Guardian Technologies, Inc , of Cincinnati, which invented the tool, has set up a program for people convicted of drunk driving and to date 246 judges in several states have sentenced drunk drivers to lease the mechanism "The ignition interlock system is now available for consumer use, including trucking companies," says Gary Schlatter, company vice president

—Robert Brody

Too drunk to drive? A computerized lock installed in your car will keep it from starting until you've sobered up

CONTINUUM



Instruments of instruction Music professor Richard Cameron-Wolfe analyzed the sounds of ancient Mayan instruments (above) to write the world's first Mayan opera

A GRAND OLE MAYAN OPERA

Their murals and instruments clearly show that the Maya were a musical people. But what did their tunes *sound* like? Music professor Richard Cameron-Wolfe of the State University of New York at Purchase thinks he may know.

After listening to hundreds of hours of Indian music from Mexico, Belize, and Guatemala, Cameron-Wolfe was able to extract the musical portions that had been influenced by or lifted from European music. "What remains," Cameron-Wolfe contends, "are remnants of ancient Mayan music."

In addition, he studied Mayan wind instruments to deduce their musical scales. "I suspected that the design motifs found in their architecture roughly represented the way they divided the octave," he explains.

So what did Mayan music sound like? The public will soon find out. Cameron-Wolfe is composing a grand opera that weaves Mayan music, magic, and mythology into a modern tale depicting the exploitation of Guatemalan Indians by oil prospectors. The opera will use both European instruments and traditional ones, so get ready for split-log drums, conch shell trumpets, and maybe even the rattle of butterfly cocoons. —Sherry Baker

"Journalism largely consists in saying 'Lord Jones Dead' to people who never knew Lord Jones was alive."
—G. K. Chesterton

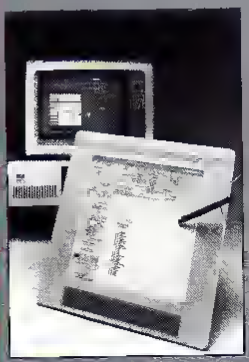
"Love your enemy—it will drive him nuts."
—Eleanor Doan

THE PAD IS MIGHTIER THAN THE PEN

A customer phones in an order to a retail store. On the other end of the line, a clerk puts an order form on top of a special pad. As the clerk scribbles down the order, the electronic pad "translates" his printed words into typewritten script and sends that script directly to a computer, which instantly records the order.

How can this electronic tablet, called Penpad, deal with the wide range of stylistic variations in the handwriting of different individuals? That was the problem facing the people at Pencept in Waltham, Massachusetts, when they set out to design the device. In the end they came up with an electronic pen and a "notepad" that uses a web of wires to register the position of the pen as it moves.

The real secret, though, is the computer software, which "decodes" handwritten script.



Finally, a computer that decodes handwritten script

by breaking down each character into its component strokes A capital *I*, for example, can be distinguished from the number 1 by the horizontal strokes at the top and bottom

Penpad which sells in a PC-compatible version for $1,095 is currently being evaluated by a number of retail stores for keeping records of credit-card transactions —Bill Lawren

MUMMIES "R" US

Interested in preserving yourself permanently? Now you can contact a company that will turn you into that most enduring of entities—a mummy "It's like flying first-class instead of coach—we're all going to the same place anyway," says Corky Ra, president of Summum, in Salt Lake City, the only company in the world with a patented process for mummification Nearly 100 people—including doctors, lawyers and an aerobics instructor—have signed up Ron Zafferer, for instance, a forty-year-old California tractor driver signed on for the service because as he puts it, "it's like changing addresses—except you move to a different dimension without your original body"

Unlike ancient Egyptians, whose mummification process, Ra says, "turned you into beef jerky," Summum's specialists soak the body for several days in a special solution composed of, among other things, formaldehyde and phenols Next, the person's organs are removed treated, and, depending on personal preference, either placed back in the body or stored in special jars The body is wrapped in a powdered thermal linen, which is treated with herbs and spices and sealed in a polyurethane membrane All this for just $7,700

Mummies can't buy you love, but how about eternal life?

Summum will also conduct funeral services in its own twentieth-century pyramid and is planning to offer sepulchers in a granite mountain sanctuary And, for an extra $18,000 plus, you can get a customized Mummiform, an airtight casket molded in human shape that's welded shut and fumigated with the inert gas argon to prevent bacterial growth

—Robert Brody

"Money won't buy happiness, but it will pay the salaries of a large research staff to study the problem"

—Bill Vaughan

"No matter how thin you slice it, it's still baloney"

—Alfred E Smith

FLUMES OF GLORY

A new marvel of high-tech engineering may soon enable world-class swimmers in the United States to make even more of a splash in international competition Last summer U S Swimming, the governing organization for Olympic swimming, installed a $1 million aquatic flume—a 65-foot-long water cascade that lets swimmers train by swimming against a force

The new flume is the most advanced in the world Shaped like a submarine, the flume forces 50,000 gallons of water to rush continuously into a long, wide, pipelike compartment made of special steel With its 260-horsepower motor, the flume may offer better laminar flow—no waves or bubbles—than any of the high-quality flumes used by the East Germans and Russians

"We're still playing catch-up with the rest of the world in applying sports science," says John Troup, director of sports medicine and science for U S Swimming "Now with the flume we should be able to leapfrog ahead."

A swimmer in the flume can actually stroke away while suspended in the same spot But he or she has to maintain a fast enough pace to keep even with the water moving backward underneath him or her It's roughly equivalent to swimming in place Because the flume can be set at varying speeds, swimmers can learn to pace themselves without having to follow flickering pace lights strung along a pool The flume also makes it easier for coaches to watch their swimmers and suggest any technical changes

From now on, all U S Olympic swimming hopefuls will undergo scientific analysis in the flume, says Troup "As swimmers get faster—and they will—we'll have the technology ready," he says

—Robert Brody

"If you jot down every silly thought that pops into your mind, you will soon find out everything you most seriously believe"

—Mignon McLaughlin

Olympic swimmers get a boost from high technology

CONTINUUM

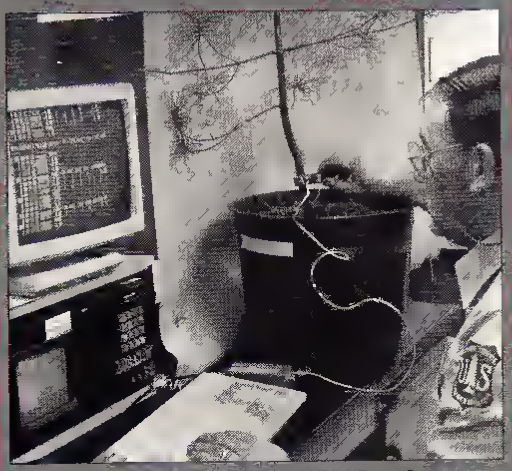
TREES THAT CRY

It s a sound you probably will never hear a sickened tree sending out a distress signal, a quiet cry in a sonorous world But a group of scientists have heard the cries and they think that some insects also hear the trees and are drawn to them like vultures to a dying animal

Researchers with the U S Department of Agriculture's Forest Service fastened sensors to bark of drought-stricken trees and clearly heard distress calls Robert Haack, an entomologist at the Forest Service's experimental station in East Lansing, Michigan, says that most parched trees transmit their plight in the 50- to 500-kilohertz range (The human ear can detect no more than 20 kilohertz unaided) 'Red oak, red maple, white pine and birch all make slightly different sounds in the form of vibrations at the surface of the wood If you slowed down recordings they would sound like chirps,' Haack notes

The scientists think the vibrations are created when the water columns inside tubes that run the length of the tree snap, a result of too little water flowing through them The tubes then fracture and send out the distinctive vibration patterns Because some insects, such as the destructive bark beetle, communicate at ultrasonic frequencies, they may pick up the trees' murmurings and begin attacking the weakened trees Haack is currently running tests with potted white pine seedlings that have been deprived of water to see if the change in sound is what is attracting the insects ' Water-stressed trees also smell differently than other trees and they experience thermal changes, so insects could be responding to something other than sound " he says

—George Nobbe



The sound of silence A researcher at the USDA Forest Service (above) listens to the cries of drought-stricken trees

WHY DOES THIS CAVE EAT PEOPLE?

According to the Greek geographer Strabo, who lived between 63 B C and A D 24 the Temple of Apollo in Hierapolis (a Greek city located in what is now Pamukkale in western Turkey) was the site of strange goings-on Animals thrown into the cave adjoining the temple never came out, and people who went beyond the mouth of the cave also apparently disappeared The priests of the temple, however, were able to enter and leave the cave without harm—although Strabo did report that their faces appeared to turn red while they were inside the cave

The ancient Greeks believed that the mysterious cave was an opening to the land of the dead ruled by the gods of the underworld But Sheldon Aaronson, a professor of microbiology at Queens College in New York, who has long been fascinated by archaeology has another explanation He believes that underground hot springs located in the area spewed deadly carbon dioxide fumes into the cave, instantly killing the humans and animals who ventured too far inside

"The area is filled with hot springs that are rich in calcium carbonate which under acid conditions produces carbon dioxide I think that steam and carbon dioxide must have seeped into the cave " Aaronson explains "The vapors would not kill you if you still had oxygen So you could survive standing in the mouth of the cave But if you went farther, you would drop dead '

But how could Apollo's priests have escaped death when they went inside the cave? "Strabo's description of their red faces gives us the clue to that " Aaronson answers "They knew how to beat the lethal gases for a short time and distance They held their breath "

While the Temple of Apollo crumbled long ago the nearby cave could still be dangerous When Aaronson visited the area two years ago, he was told that some Australian students had recently disappeared inside the cave 'The Turkish government put iron bars over the opening to prevent other people from ever going in, he says "As far as I know the Australians were never seen again '

—Sherry Baker

"Miracles are so called because they excite wonder In unphilosophical minds any rare or unexpected thing excites wonder, while in philosophical minds the familiar excites wonder also "

—George Santayana

"The best way to keep children at home is to make the home atmosphere pleasant, and let the air out of the tires "

—Dorothy Parker

ARTICLE

RULES OF THE GAME

BY G. GORDON LIDDY

Could terrorists cripple the United States? A former Washington aide tells the Oval Office how

PAINTING BY ALAN REINGOLD

On my corner the drug guys hang out cracking (which in this context means trading insults), until launched to the pay phone by their beeping pagers. Current fashion dictates that you clip these in the bottom crook of pants pockets.

To the uninitiated, this scene is no big deal, save perhaps for the oddity of crackozoids in rags sporting pricey pagers. This stealthy curbside use of high-tech com gear is just good business. Crime today is a paramilitary operation, and just like an army, it depends on com gear as much as on weaponry.

Beepers and cellular phones let you coordinate complicated plans involving men and material constantly on the move. That's how loads of coca leaf make it through the jungle to basuca-paste factories and then via overloaded planes and boats through the AWACS (airborne warning and control system) net of our coastal defenses so that tiny empty crack vials eventually wind up in the gutter at the feet of the drug guys on my corner.

Today drug gangs deal mostly in drugs and weapons and have no political or strategic agenda. But in 1986 a terrifying episode perhaps heralded a shift in this direction. A drug gang in Chicago reached out and phoned someone in the Libyan government—possibly strongman Muammar al-Qaddafi himself—with an offer to commit terrorism for a price.

Luckily the FBI tumbled onto the scheme. Now the gang leaders are doing time. International terrorism—so long a tragic staple of the rest of the world's bitter diet—has yet to reach the U.S. mainland. But the signs are clear that violence is becoming a multinational business.

It's not just the readily available beepers and car phones—and bugging and antibugging devices, too, for that matter. These days $600 buys you a semiautomatic Uzi—the terrorist's favorite. No, you can't get that deal in my neighborhood. For the Uzi you have to go to the Woolworth outlets in either North Miami Beach or Hollywood, Florida.

The memorandum that follows, so artfully done by G. Gordon Liddy, elucidates one way that terrorism might strike at home in the all-too-near future—in the hands of a small, Communist-backed cadre. These terrorists would hit power plants, rail lines, airports, and natural gas pipelines. Although Liddy's tale is pure speculation, it is based on technologies and tactics that are very real.

Knocking out these essential parts of a country's infrastructure is also a preferred way to wage modern war, say proponents of a new, deadly strategy called low-intensity conflict. This approach is exemplified in a profusion of brushfire conflicts around the globe. Freedom fighters in Nicaragua and Afghanistan do it. Marxist rebels in El Salvador do it. But so do the Irish Republican Army (IRA), the Palestine Liberation Organization (PLO), and the Red Army Faction.

How military strategy evolved to this sort of warfare—and the likelihood that it will backfire, fanning terrorism's flames and bringing it *all* back home—are the subjects of the compelling piece on page 46 by Peter Kornbluh, coeditor with Michael T. Klare of the book *Low Intensity Warfare: Counterinsurgency, Proinsurgency, and Antiterrorism in the Eighties*.

Debate rages naturally, over who is to blame for the brutal low-intensity conflicts now dotting the globe. It's tough singling out one guilty party, considering how fashionable small, cool conflicts have become.—The Editor

THE WHITE HOUSE
TOP SECRET

PENUMBRA IKON ZOAR JENNIFER HELOS
SENSITIVE
NODIS
09 September 1999

MEMORANDUM FOR THE PRESIDENT
FROM AXEL JOHANSEN [Chief of Staff]
SUBJECT HOW AMERICA WAS SHUT DOWN

This memorandum is a summary of, and attached to, the comprehensive damage report, physical and political, on the coordinated terrorist sabotage attack on the night of second August. The political section has, as ordered, been expanded to include a report on the Capitol Hill riot of last Thursday, which cost 13 lives, including those of the speaker of the House and a congressman, before order was finally restored.

U.S. Commercial Aircraft Industry 90 Percent Inoperative

The rendering of U.S. jet equipment inventory unusable cannot be attributed to the events of second August. The intelligence community and the Federal Bureau of Investigation are, however, unanimously in agreement that the two are part of the same overall operation. This conclusion is based primarily upon the evidence taken from the body of a female slain by SEAL Team 3 on second August in the San Diego area while she was participating in the attack on the national electrical power distribution system (next heading). But for this fortuitous event, the sudden structural failure of several aircraft belonging to each U.S. carrier would still be blamed on age (à la the 1988 Aloha aircraft incident, when metal fatigue caused the roof of a Boeing 737 to rupture in flight). As it is, we have had to ground the U.S. civil commercial aviation fleet for an indefinite time, but at least we know what to look for.

Japanese intelligence has confirmed that the body of the woman slain by the SEALs is that of a member of their "Red Army" group. On her person was an item at first thought unrelated to her mission

what appeared to be a U.S. made Magic Marker, which although not dried out did not mark. The fluid it contained has now been identified by researchers at the Defense Advanced Research Projects Agency (DARPA) as nearly chemically identical to our classified liquid metal embrittlement (LME) agent. Unfortunately, prior to being added to the classified technologies list, the LME agent was discussed in open literature.

With the aid of the LME marking device, a terrorist could gain, and obviously has gained, access to aircraft and by the simple process of drawing a virtually undetectable line across fuselage components subject to stress, could cause the metal under the line to become brittle enough to fail shortly after it is next subjected to the stress of flight.

It will take a long time to check every aircraft unless under interrogation any of the few prisoners we were able to take will talk. They are being questioned by CIA over the protests of the FBI, because in this rare instance CIA methods are justified for domestic use and are not in the FBI repertoire.

We have been able to achieve 10 percent capacity of normal civil or commercial air transport only because the smaller turbine commuter aircraft were not attacked, nor were the aircraft of foreign carriers, a number of which have generously leased us spare aircraft at extortionate rates.

Even assuming the best, the fear of the American public for the safety of our civil fleet will have a lasting, very economically damaging effect.

Nation's Capital and Seven Largest Metropolitan Areas Blacked Out Indefinitely

Since the devastating New York City blackout of 1977 much has been done by way of redundancy to protect entire nets from chain reaction failures. Nevertheless the terrorists exploited a vulnerability brought to governmental attention several administrations ago (and ignored

THE EDGE OF MIGHT

As the United States heads toward the twenty-first century, our national security managers are redefining the type of warfare this country is likely to wage. With the signing of the U.S.–Soviet arms reduction treaty and the advent of *glasnost* and *perestroika*, the Cold War is warming; the prospect of fighting a conventional ground war in Europe and risking a nuclear apocalypse with the Soviet Union grows increasingly unlikely. U.S. military strategists are therefore turning their attention to fighting wars in the Third World.

"In the parlance of the Pentagon, Third World violence and the U.S. response to it are known as low-intensity conflict or LIC (pronounced *lick*). In 1986 the Joint Chiefs of Staff came up with a broad and rather antiseptic definition: 'Low-intensity conflict is a limited politico-military struggle to achieve political, social, economic, or psychological objectives. It is often protracted and ranges from diplomatic, economic, and psychosocial pressures through terrorism and insurgency. Low-intensity conflict is generally confined to a geographic area and is often characterized by constraints on the weaponry, tactics, and level of violence.'

The enemy no longer wears a uniform, drives a tank, or mans a battleship, say proponents of LIC; he is a terrorist who takes hostages in the Middle East and plots attacks inside the United States, or a Soviet-sponsored guerrilla inspiring revolution against pro-American regimes. In recent years LIC warriors, among them men like Lieutenant Colonel Oliver L. North, who headed the National Security Council's Counterterrorism and Low Intensity Warfare Group, have zealously pushed the Pentagon to begin allocating massive resources for new strategies, new bureaucracies, and new weapons to engage in counterinsurgency, proinsurgency, and antiterrorism campaigns.

The evolution from conventional to unconventional warfare, however, does not mean that the world will be a safer place. One man's "freedom fighter" is another's terrorist. Indeed, proponents of LIC who advocate Rambo-like responses to terrorists and revolutionaries in the name of promoting peace and stability may well be pushing this country—and the world—toward more terrorism and more war.

In the wake of Vietnam, the American public has repeatedly balked at sending the Marines into an overt protracted Third World conflict. It has become essential for U.S. policymakers, therefore, to use overt military force only as a last resort and to find, instead, less visible means to wage war.

To this end, the Reagan administration began to reorient the U.S. military toward covert, low-intensity conflict in Central America, the Middle East, Asia, and Africa and away from traditional scenarios of war—such as the clash of armies in the European theater. To cut through turf battles between elite units of the Army, Navy, and Air Force, in 1987 the administration established a unified military command for special operations and beefed up the CIA's war-making capabilities.

Vast sums have already financed the CIA's contra war in Nicaragua (approximately $250 million), a massive U.S. counterinsurgency program in El Salvador ($3 billion), and the backing of the mujahedeen in Afghanistan ($1.5 billion), among other LIC operations.

In the future we can expect to see additional U.S. military advisers and hundreds of millions of dollars in security assistance going to El Salvador as its guerrilla war heats up once again; an escalating U.S. counterinsurgency program in the Philippines; and increased U.S. diplomatic and economic intervention in Chile. We can expect to see U.S. policymakers sending scores of economists, biologists, agricultural specialists, and other professionals to Mexico—where political and economic instability has become a key security concern. And although we may not see it then, we can expect that CIA covert paramilitary and political operations, made into a routine foreign policy tool during the Reagan years, will continue in every country where U.S. policymakers arrogantly believe they can shape events.

If recent history offers any lessons, the proliferation of U.S. intervention in low-level conflicts around the globe will not advance U.S. national interests in peace and security. Low-intensity wars have a way of escalating. In Vietnam, for example, Americans began as advisers to foreign military forces and wound up fighting on the front lines.

Proxy forces are also hard to control. For example, when the CIA gave "Stinger" antiaircraft missiles to the Afghan rebels, a number of them were stolen, or sold, to Iran, making civilian air travel a more dangerous proposition in that part of the world. When the CIA sought in 1985 to take aggressive counterterrorism measures against Mohammed Hussein Fedlallah, the mastermind behind the 1983 bombing of the U.S. Marine compound in Beirut, its "assets" detonated a car bomb in Lebanon that killed 80 innocent people but missed the intended target. Thus in an attempt to fight terrorism, terrorism was committed. To some this was a moral outrage; to others, a regrettable incident. In either case the event comes with real-world implications. Those 80 human beings left relatives who may well seek to retaliate by joining or supporting those who look upon the United States as the "great Satan." —Peter Kornbluh

since) by Dr Robert H Kupperman of the Center for Strategic and International Studies The terrorists did their homework very thoroughly

Kupperman's point is as follows In order to achieve economies of scale generated electrical power is transmitted over long distances at extremely high voltage (EHV) Think of a power line as a water pipe In electrical terms, amperage is the flow of water through the pipe Voltage is the pressure The higher the pressure the greater the amount of water a given pipe can transport To get water under pressure requires a pump To get electricity under pressure requires a transformer EHV requires an EHV transformer, both to step the voltage up at the beginning of its journey and down at its destination

There are only about 500 EHV transformers in the entire nation Their locations are shown on a map available to the public Most are protected by no more than a chain-link fence and warning signs that serve to confirm exactly what they are EHV transformers are sophisticated pieces of equipment not manufactured in the United States The lead time for delivery of a new one from abroad is 18 months They can be put out of operation by a high-powered rifle

Thus a small number of terrorists—a few using 458 Winchester magnum rifles (as was the woman killed by the SFALs) and the rest Israeli-made copies of our Marine Corps' new 40mm lightweight, polymer/ceramic, near-handgun-size grenade launchers—took out the few key EHV transformers around Washington, DC, New York City/Newark, Boston, Chicago, Dallas/Fort Worth, Atlanta, Oakland/San Francisco, and Los Angeles. San Diego was saved when an element of SEAL Team 3, on a security penetration test mission, came upon one of the terrorists who panicked and fired on them. After killing her, the SEALs grasped her mission, alerted their superiors, and in short order we had nearly half the few prisoners captured to date.

The aftermath of the EHV attack has been devastating. There is no power for the water supply pumps. The effects of arson are impossible to control. Martial law is barely able to maintain order now that the stores are looted and burned. Vigilante justice is rampant. Sanitation has broken down, and the rats are out of control in New York City It will take six months to a year, under emergency conditions to acquire and replace the transformers and restore the electrical power.

North–South Rail Traffic in Eastern United States Severed; Much of Strategic Rail Corridor Network (STRACNET) Out

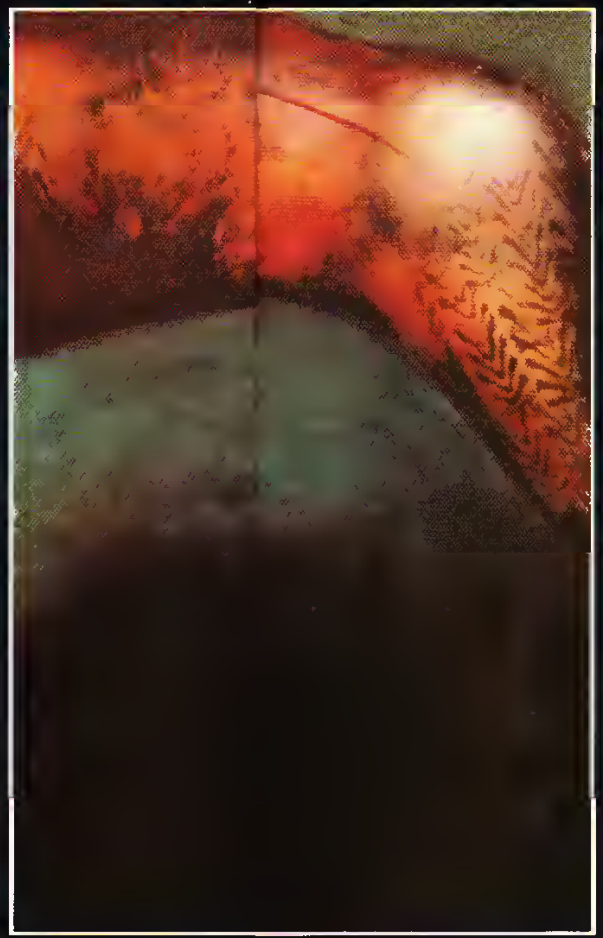
Unfortunately all major north–south railroad traffic in the eastern United States funnels through two choke points: a single strategic railroad bridge over the Potomac River between Washington, DC,

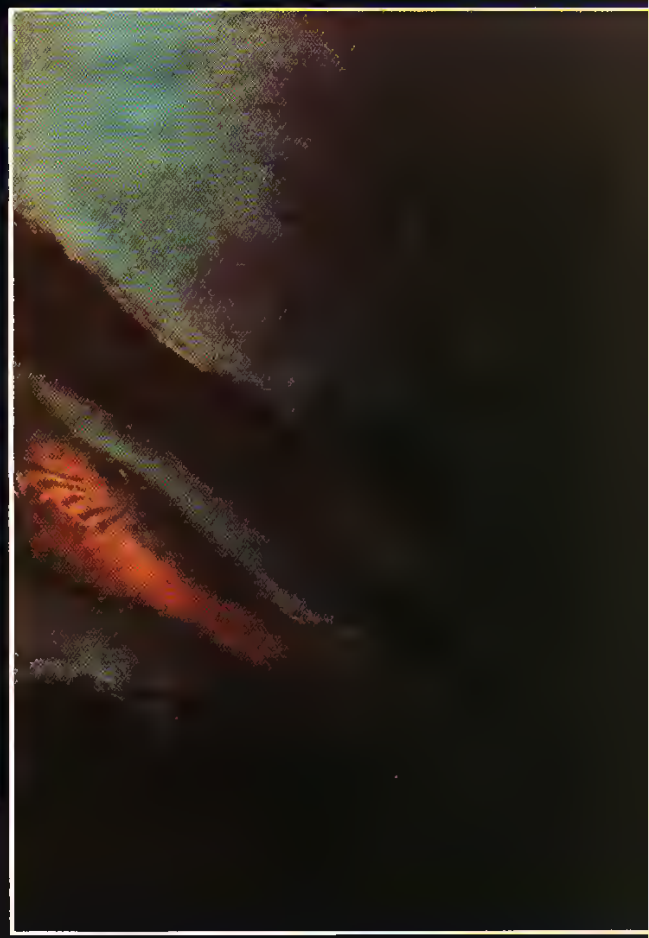
CONTINUED ON PAGE 78

ARTICLE

ARK DE TRIOMPHE

BY CATHY SPENCER





Science's success in saving the ferret, wolf, grizzly, and cheetah could prove to be a step toward preserving Earth—and all its inhabitants

PAINTING BY MARSHALL ARISMAN

Hundreds of rivets hold an airplane together. If one of those rivets is lost the aircraft is in little danger of crashing. As more rivets are removed, however, the chance of disaster steadily increases. Paul Ehrlich, a biologist and one of the leading spokesmen for world conservation, compares biological diversity—plants, insects, fish, and other animals—to the rivets of an airplane. One thousand species near extinction each year, and by the Nineties, the figure may rise to more than 10,000 a year—or one species every hour. "The more species lost," says Ehrlich, "the greater our chances for meeting an ecological disaster that will cause Spaceship Earth to crash."

Thirty million species are thought to populate the earth. As the tropical rain forests in Central and South America are developed, half of the world's arsenal of plants and animals literally goes up in smoke. Agricultural practices wipe out thousands of plants and animals; many species are being hunted to extinction, and land development eliminates prime habitats for a wide variety of species.

Species lost in North America in the last ten years include the dusky seaside sparrow, whose last member died in captivity on June 16, 1987; the Palos Verdes blue butterfly of California; the Louisiana vole; Sherman's pocket gopher; and the killifish, a Western species of fish. By 2000 the ruby-throated hummingbird, the rough-leaved loosestrife, the southern sea otter, and Kemp's Ridley sea turtle may also be memories.

The relationship between man and all other life forms ensures our survival, and as species begin to disappear, scientists scramble to protect them. Breakthroughs in technology and medicine that have transformed our world in the last few years now provide scientists with ways to preserve species incapable of surviving on their own. Wildlife biologists at Yellowstone National Park, for instance, are observing the effects of stress on elk by implanting heart monitors in the chests of some of these animals. New strains of vaccines, such as a genetically engineered vaccine for rabies, are being tested to protect species from deadly viruses. As the populations of such endangered species as wolves and grizzlies decrease, it may become necessary to inoculate the animals in order to protect the remaining individuals.

COMMON BONDS

Just why is the fate of these species inextricably bound up with our own? Because each and every species plays a significant role in the life cycle of others. Some species provide us with food, others supply cures for deadly diseases, and others keep our environment clean.

Before researchers can help species recover, though, they need to know how a species interrelates with the other species in its ecosystem. Scientists for instance once called old-growth forests biological deserts—stagnant, useless remnants of nature. Recently, however, studies have revealed how important these ancient trees are to the health of the rest of the forest.

All forests reduce soil erosion and siltation, which helps keep our water clean and protects the fish in streams, lakes, and rivers. The extensive root systems of ancient stands are better than most forests at trapping nutrients, explains Jerry Franklin, the chief plant ecologist for the USDA Forest Service. Because fewer nutrients are lost and less sediment escapes into the streams, old-growth forests (which are primarily in the Pacific Northwest) tend to produce cleaner water and support larger fish populations than do younger stands of trees.

The canopies of these trees are equally important. By adapting equipment from mountaineering and sailing, scientists have been able to climb and work in the 300-year-old trees without harming them. "Hundreds of organisms have been found to live in the canopies," says Franklin, "from lichens, invertebrates, and arthropods to birds and mammals."

"In the next decade, thanks to radio tracking and studies done on the behavior of other populations of wolves, the wolf may again take up its role as one of the park's three dominant predators."

In the last 30 years, however, these ancient trees have been cut down at an average rate of up to 170 acres per day on both private and public land. As these stands of old-growth forest disappear, the population of the northern spotted owl—an "indicator" species—declines. An indicator species can be used to measure the health of plant and animal communities in the forest. By preserving an indicator species, habitat scientists preserve a whole spectrum of biological diversity. The owl's entire habitat needs to be intact for a healthy population of this species to exist. If the owl begins to die out, this indicates that something is wrong in the habitat. "If our planet isn't safe for birds, fish, and insects, then it's not safe for humankind," says Michael Bean, chairman of the wildlife program at the Environmental Defense Fund.

Alan Franklin, a research associate at Humboldt State University in Arcata, California, is studying the survival and reproduction habits of the northern spotted owl. From April 1 to August 31, Franklin and his colleagues spend ten days at a time in the forest tracking the birds and four days resting back in town. The study team works 16 to 18 hours a day and sleeps on the forest floor in the open under the stars. "The spotted owl needs thousands of acres to survive," says James Pissot, a wildlife specialist for the National Audubon Society. Old-growth forests provide a good habitat for the owl's main food sources, the northern flying squirrel, the red tree vole, and wood rats. The multilayered canopy—cooler in summer and warmer in winter—suits the owl's climatic needs as well as protecting it from becoming a meal for the great horned owl.

Creating a safe environment for all life forms is the goal of hundreds of scientists from dozens of different disciplines. And perhaps for the first time in years, man's concern for his fellow creatures is growing. This was evident in the case of the three California gray whales trapped in the ice off Point Barrow, Alaska, last October. Scientists, Eskimo, environmental activists, and the crews of two Soviet icebreakers joined together to help the whales make their journey. An Eskimo elder told his people to "think like the whales" as the escape route was cut with chain saws in the ice. Without the aid of humans all the whales would have died.

Unfortunately, not all of man's attempts to save plant and animal species end so successfully. Part of the reason: It isn't always easy to decide how man can best help preserve other species. Two different schools of thought have evolved among scientists and environmentalists. Some scientists believe it is usually best to let nature run its course and will thus allow species on the verge of extinction to die out. Other scientists, however, feel that each species must be protected in order to preserve the delicate balance of the ecosystem. They will take extreme measures to save a species that's on the brink of extinction.

YELLOWSTONE: THE EXPERIMENT

Policies used to maintain the plants and animals in Yellowstone National Park have relied on both these schools of thought. A gigantic biological laboratory teeming with wide varieties of species, Yellowstone has, over the years, served as a window on nature. Like Alice in Wonderland, a visitor entering Yellowstone steps into a world unlike anything else on this planet. Virtually unchanged for millennia, the park contains dark crater lakes where beaches are covered with black volcanic sand. White pelicans glide like prehistoric birds over the rock formations that sculpt the terrain.

The National Park Service, responsible for the day-to-day care of Yellowstone, strives to protect and preserve the park in its natural state. The agency has

had its share of successes and failures. Had some of the natural processes been left undisturbed, severe problems might have been avoided. From the early 1900's to the late Sixties, "the function of the natural system was totally disrupted," says biologist Paul Ehrlich.

In the early 1900's, for example, the Park Service was convinced that predatory mammals were killing off the entire population of deer, antelope and bighorn sheep in Yellowstone. As a result government agents shot 781 mountain lions, 20 wolves, and an undisclosed number of bears, as well as other species. As it turned out, the predators had not been responsible for the decline of other species in the park; the Park Service's own program to feed the elk populations with domestically grown hay had caused the problem. The hearty diet drastically increased reproduction rates, and the elk began overrunning and overgrazing Yellowstone. This forced the deer, antelope, and sheep to move to areas outside of the park where they could still find something to eat.

When Yellowstone scientists began to understand that sometimes a natural process is good for the ecosystem, one of the most controversial policies was established. In 1972, the Park Service decided to allow natural forest fires to burn (fires started by lightning are considered natural). The "let burn" policy met with a nationwide uproar when fires raged in Yellowstone last summer. Some members of Congress called for the resignation of William Mott, the director of the National Park Service, and Secretary of the Interior Donald Hodel and President Ronald Reagan were both quick to support a public outcry to stop the Park Service from letting natural fires burn. Bleak news reports fueled the fear that the entire park was being destroyed.

In actuality, many benefits were reaped from the fires. According to park superintendent Robert Barbee, fires help renew life in lodgepole pine forests, the predominant species of pine tree throughout Yellowstone. Without fire, the trees cannot repopulate. The pine cones release their seeds only after being exposed to the high temperatures of a fire. "Some of the cones had laid dormant, waiting for fire since the late 1500's," Barbee explains.

Furthermore, few animals were known to have been killed by the fires. In fact, the fires helped create new wildlife habitat. Green shoots of grass appeared over the blackened forest floor three weeks after some areas had burned. The ash left by the fire puts rich nutrients back in the ground, which then promotes succulent new growth.

"The fires didn't burn as much forest as the news reports indicated," says David Vales, a doctoral candidate in wildlife biology at the University of Idaho. "The figures indicating the number of acres burned refer to the perimeter of the fire. Within that fire perimeter by early September, only about forty or fifty percent of the forest actually burned." Since then, prolonged dry periods have caused additional areas to burn. When fire moves through a forested area, a patchwork is created. Driven by wind, the fire pushes forward, igniting only about one third to one half of each section of forest.

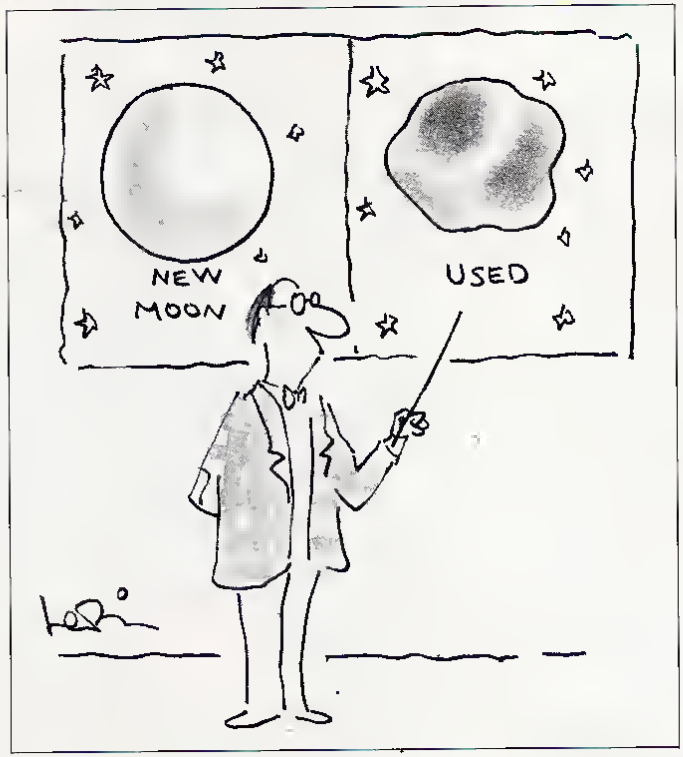
Vales, who is studying a small number of mature bull elk to learn about their winter survival strategies, tried to stay in the field during the fires to watch his subjects. Some days the smoke loomed too thick to fly over the summer grazing areas and at one point Vales, threatened by fire, had to move out of his living quarters. But this was the opportunity of a lifetime for a wildlife biologist. Rarely do such extensive fires affect a large wildlife refuge, and scientists are unsure how much human intervention should be applied in such a situation. Park Service managers now must decide if the policy to let fires burn naturally in Yellowstone will continue through this year. This decision, however, may already be greatly influenced by strong public opinion.

Every day the Park Service is forced to make decisions for or against nature taking its course. And the right decision is often unclear. In the spring of 1984, for instance, the Park Service let nature decide the fate of four bears. A female grizzly and her three cubs accidentally became stranded on an island in the middle of Yellowstone Lake. After much deliberation, the agency chose not to intervene. All four bears, unable to help themselves, slowly died of starvation.

When man must intervene, he is armed with high technology. Recent medical breakthroughs in reproductive biology and genetics have already been adapted to save other species. In an effort to increase the populations of some species, reproductive biologists are implanting the embryos of zebras into horses, for example, and geneticists are breeding animals of the same species but from different zoos to produce offspring with more varied genetic makeups. The desire and need to preserve other life forms have become so urgent that soon after a scientific breakthrough occurs, it is applied in the field as part of programs to assist wildlife biologists.

Through the technique of observation, scientists including Jane Goodall, George Schaller and Mark and Delia Owens are making the most valuable (and probably the best-known) contributions to the preservation of other species. Most biologists in the wild observe all day or all night, while the rest of their time is spent huddled in a tent in the windswept Kalahari Desert or in subtropical climates.

Researchers in Yellowstone also make observations and collect data. In 1986



for example, Maurice Hornocker director of the Wildlife Research Institute at the University of Idaho began a five-year study on the mountain lion. The study team captures, tranquilizes, and tags each lion, then attaches radio transmitters to each animal to monitor its behavior and habitat requirements. Researchers hope to determine how the lion fits into the overall scheme of the Yellowstone ecosystem and what action, if any, man should take to help this species.

The mountain lion recovery program reflects man's changing attitude toward his fellow creatures. The mountain lion is one of the three big North American predators, the other two are the grizzly and the wolf. Hated and feared by man, predators were either killed or forced to flee to remote areas when humans tamed the wilderness in this country. Now, however, we've come to realize that predators, like all species, play a significant role in the overall balance of nature.

"The predator control program in the early part of this century wiped out the entire population of lions in Yellowstone," says Hornocker. When he began his study three years ago, he didn't believe a single lion would be found in the park. Preliminary reports showed, however, that perhaps 20 lions resided full-time in the park. Hornocker feels that most of these mountain lions migrated from Montana.

Other findings suggest that the Yellowstone lions appear to have developed characteristics unlike those of other lion in the country. According to John Varley, director of research at Yellowstone, these lions weigh up to 25 pounds more than other mountain lions, which may indicate an evolutionary trait developed to overcome a 700-pound elk.

The researchers tracking the lions are also trying to determine if the lions follow the elk herds into their summer ranges. Even though most of the big game animals—deer, elk, bison—stay in the park year-round, during the winter they migrate to lower elevations where there is less snowfall. If the lions follow their prey into summer ranges, then they are evolving according to the availability of their food source. All other mountain lions set up a home territory and never migrate. The Yellowstone lions would have to set up a summer and a winter range—an unusual trait, says Varley.

"The mountain lion is a real success story," says Hornocker. "It can adapt to many different situations and has been able to cope with modern times as long as its habitat requirements are met." All the mountain lion requires from man is a minimum amount of protection.

The wolf and the grizzly, on the other hand, have experienced much more difficulty in coping with changes and have survived in only a few isolated pockets.

The eerie cry of the wolf has been absent from Yellowstone National Park and its environs for more than half a century.

Extraordinary animals, wolves share food with the old that can no longer hunt, give one another gifts, remain monogamous, and watch over their pups. According to recorded history, a wolf has never killed a human, and it will move out of an area if more than three humans occupy a square mile. In the next decade, thanks to radio tracking and studies done on the behavior of other populations of wolves, the wolf may again take up its role as one of the three dominant predators in the park. The Park Service plans to bring the wolves back, but unlike their predecessors, these wolves will be manipulated by man. Radio collars will monitor and control their activities as they move about the park and into outlying areas. If researchers want to examine or move a wolf, particularly one that has strayed, the team will locate the animal from the air and push a button connected to a radio signal transmitter. That in turn will activate a needle in the animal's collar, injecting a tranquilizer into its neck. Otherwise, the wolf's strong homing instinct may compel the animal to return to its home range.

Scientists will establish three management zones for the wolf recovery program. There are no fences or gates to keep the wolves inside the park boundaries, so outlying areas of public and private land are part of the zoned areas. In the first zone wolves will be allowed to roam freely. They will share the second zone with other users, such as ranchers, hunters, and farmers. In the third zone, wolves will be relocated or killed if they interfere with other land users.

"Restoring the wolves in Yellowstone will have a major impact all over the country and probably all over the world," says Hank Fischer, the northern Rockies representative for Defenders of Wildlife, a nonprofit educational organization. "The world will see that we respect the wolf's right to exist." The return of the wolf may also encourage other parks to start reintroducing predators that have been lost from their original habitat. A survey of park visitors indicates that they are in favor of reintroducing the wolf by five to one.

Unlike the wolf, the grizzly managed to hang on to its place in Yellowstone. Still threatened with extinction, the grizzly is vulnerable to any change in its environment and must be watched closely if it is going to survive. DNA fingerprinting—a method used to study each individual chromosome—is now helping park scientists develop an acute understanding of the grizzlies in Yellowstone. The DNA imprinting will help distinguish the differences between the Yellowstone grizzly and the Glacier Park grizzly and will also reveal the distinct characteristics of each individual bear.

Park scientists are most interested in the population dynamics of the grizzly—in other words, charting a family tree. Female grizzlies may mate with two or three male bears during each breeding season. If this is true, scientists speculate that it's possible for separate ova to be fertilized by each male, and if so, each cub in a litter may have a different father. DNA analysis should determine which bears have fathered which cubs in a litter. One half of the DNA fingerprinting of a mother and daughter will be identical, and the other half of the daughter's DNA will match one half of her father's. The researchers hope to find out which males are doing the mating in the park and how the bears are related. This will provide insight into how the bears from different parts of the park and outlying areas interact. Scientists can then predict where bears reside at certain times of the year and how far they'll roam to mate.

Counting a population of bears is no easy task. Elusive animals, they run away from approaching humans. Yet the Park Service needs to ascertain the number of bears so scientists can intervene if the population begins to drop. An elaborate system has been devised to determine the approximate size of the grizzly population. Characteristics such as birth rates, death rates, number of young per animal, and size of litters are all fed into a computer program that estimates the overall life span, breeding age, and other idiosyncrasies of a future population. These numbers are then compared with a number determined by counting the females with newborn cubs.

Female bears have cubs every three years. In any given year (year one) there are at least so many females with newborn cubs. In the following year (year two) a different group of females will have newborns. In year three those females with new cubs represent yet another group of females. This process determines the approximate number of breeding females in the Yellowstone grizzly population. The computer figures, plus the female–cub ratio, show a yearly increase of 1.5 percent since 1983 (three times greater than the increase in the world's human population).

Duplication in the count, however, is bound to occur, says Frank Craighead, who, with his brother John, conducted the first scientific research on the grizzlies in Yellowstone. In 1988 they counted 19 sows with newborn cubs, which is a good indicator of the population recovery. "But what is important is how many yearlings show up in the spring," Frank Craighead points out. "If only a fourth of the yearlings live through the winter, then that is not a recovering population."

During a study from 1959 to 1970 the Craigheads focused primarily on the grizzlies that came to the park garbage dumps. The brothers pioneered tagging, radio tracking, and identification techniques that have become a part of every wildlife field study. The Craigheads tracked grizzlies to their dens and col-

Leon's done it! He's discovered this year's disease!'

CONTINUED ON PAGE 108

Bugs have been poked, pinned, probed, and even sued And yet, they thrive

GARDEN OF EARTHY DELIGHTS

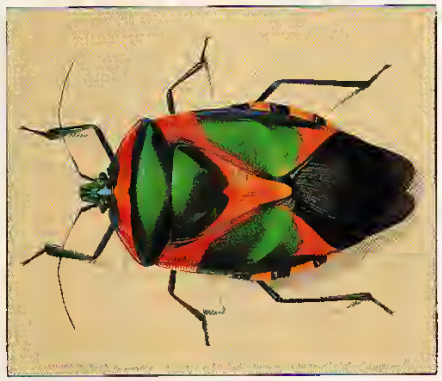
BY JANE BOSVELD

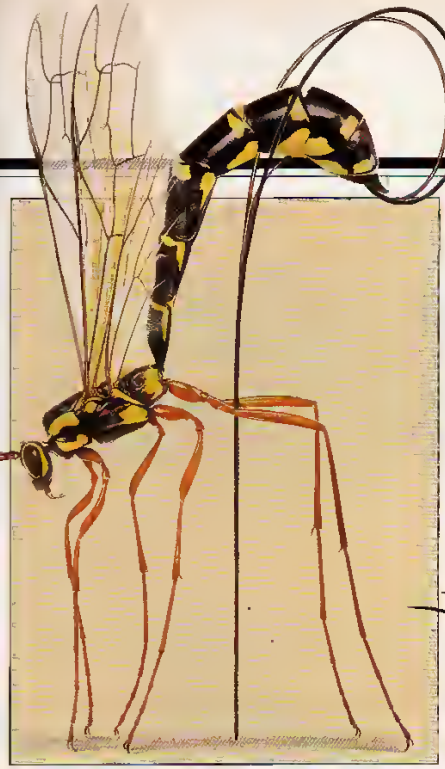
In 1545 one of the strangest court cases in French history was filed. The owners of a vineyard sued a group of beetles that had infested their vines. The court appointed a lawyer to defend the beetles, but the bugs abandoned the vineyard before their case was heard. Forty-two years later the beetles returned, and once again a suit was filed against them. This time the beetles stayed long enough to hear the verdict. The vineyard owners, the judge ordered, were to provide another piece of land with enough trees and shrubbery to keep the beetles happy.

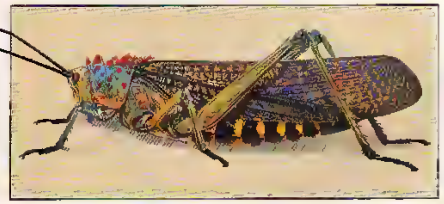
Such respect for the foraging needs of insects seems odd in this age of pesticides, yet it was not until this century that entomologists began unraveling the biology and behavior of class Insecta and began learning how to control pests. Many of the men and women who have devoted their lives to studying insects, however, have done so more out of curiosity than out of revenge. Take the case of Frenchman Jean-Henri Fabre, for instance. He longed for just one thing in his life, a bit of ground cut off from human habitation, a living laboratory in which to observe and record the everyday endeavors of insects. Adorned in a black felt hat and linen jacket, puffing on a briar pipe that was forever going out, the simple professor amassed a cornucopia of insect lore. He revealed, for example, how a tiny beetle called the bear larinus can survive the winter by hollowing out a chamber in the head of the thistle, a protective cave in which it hibernates like a bear, and how certain species of insects lay down trails of scent that guide them back home after a day's journey. Fabre's essays on the lives of insects were enormously popular. No less a writer than Victor Hugo, for instance, labeled Fabre the "Homer of insects."

Although the Frenchman did as much as anyone to popularize the habits of common bees, beetles, moths and other bugs, he

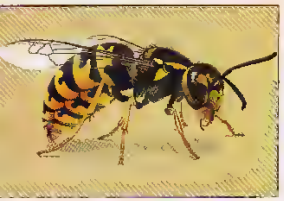
PAINTINGS BY BERNARD DURIN

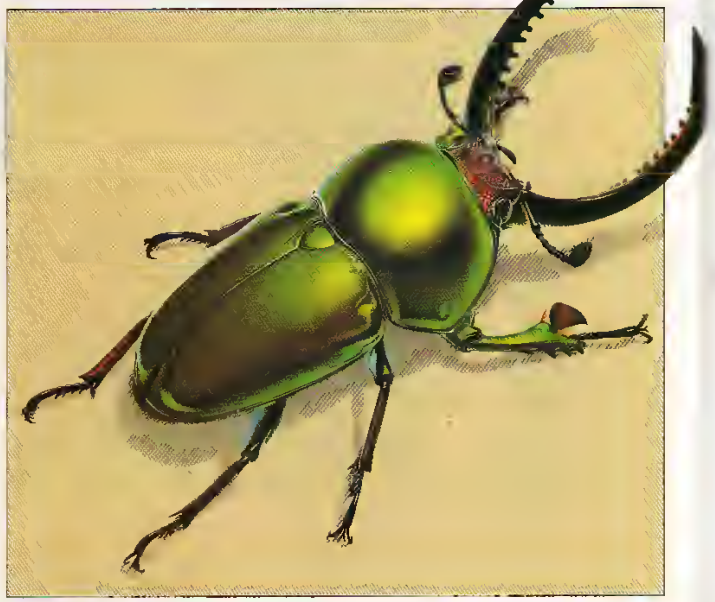






Clockwise from far left: Maybe the largest of the scorpions, *Paedieus imperator* has an enormous stinger, but its poison is not particularly harmful to humans; a female wood-boring pipe cleaner; a click beetle; a Madagascan grasshopper; a South American rhinoborned dung beetle; a wild bee, also South American; a New Guinean scent beetle, a type of weevil; a brilliantly colored African bedbug.





received much in return "Dear insects," he wrote, 'my study of you has sustained me in my heaviest trials.'

Alfred Russel Wallace and Charles Darwin, the architects of evolutionary theory were also fascinated by bugs. Darwin, a "beetlephile" of the first order, stopped at nothing to obtain a new specimen. "One day," he wrote, "on tearing off some bark [from a tree], I saw a new kind [of beetle], which I could not bear to lose, so that I popped the one which I held in my right hand into my mouth. Alas! it ejected some intensely acrid fluid, which burnt my tongue so that I was forced to spit the beetle out, which was lost, as was the other one."

Darwin, Wallace, and Fabre lived during the Victorian era, a time when anyone who was anyone owned a butterfly net and set out on afternoon collecting picnics. This Victorian passion, however, didn't survive for long; bugs once again slipped into anonymity.

But why? As these portraits by French artist Bernard Dunn (1940 to 1988) show, there is no shortage of wit and whimsy among invertebrates. Indeed, if the bugs pictured here had been gathered from the surface of the moon, they would be the biggest attraction in every natural history museum in the world. If they equaled even house cats in size, they would be the focus of safaris.

It doesn't seem to matter that they provide many essential services. Insects condition soil, break down deadwood, and pollinate flowering plants. A small relative of the aphid produces shellac, sealing wax and many dyes also come from the busy work of insects.

Despite their good works, however, we have relegated insects to the classification of pests. Perhaps it is time to reconsider our verdict. ☐☐

Clockwise from top left: A ladybug found throughout Asia; an Indian metallic beetle; a wingless weevil from South Africa; the "giraffe" beetle uses its elongated neck to reach higher leaves; Madagascar's *Lemprogenia rothschildi* beetle; a South American cicada, or lantern fly; a stag beetle from New Guinea; Europe's common wasp; and holding up the whole page, of course, is the Central American Hercules beetle.

A nanometer equals one-billionth meter. This scientist claims we can build tiny nanomachines that will fabricate steaks from straw and dirt, spaceships from "seeds," cure diseases—in short, remake the whole physical universe. Is all this possible?

INTERVIEW

ERIC DREXLER

In the spring of 1977, when a senior at MIT, Eric Drexler got an idea for a new machine. As he remembers it, "I got to thinking about what could be done if we could engineer the kinds of molecules and molecular devices that biologists were finding in organized systems. You could, I realized, actually build molecular machines and use them to build even better molecular machines. Pretty soon you'd have a very powerful technology—one that essentially gave you complete control over the structure of matter." Drexler later christened this process of manipulating nature atom by atom "nanotechnology." Hitherto, manipulation of matter has been done by moving great gobs of molecules all at once. Even "small" mechanisms, like the tiny gears and springs inside a wristwatch, are composed of many trillions of atoms of metal. A quick glance through a microscope reveals numerous hills, valleys, and other deviations existing on the watch works' surfaces. Compared to objects on the nano scale, even something as fine as an eyelash is a "bulk" object—a veritable sequoia. Drexler's nanomachines—tiny robots called assemblers—will be smaller than living cells, smaller even than some viruses. These assemblers will ply their trade with the actual building blocks of creation, individual atoms, much as a bricklayer works with individual bricks.

This unprecedented control over matter enables nanotechnology to promise feats that stagger the imagination. In *Engines of Creation*, published in 1986, Drexler showed how a battalion of assemblers could "grow" a rocket engine out of ordinary chemicals plus a rocket engine "seed." If that sounds preposterous, consider that this rocket engine would not be made of mere aluminum but of diamond and sapphire.

And that will be one of nanotechnology's *easier* feats. The

PHOTOGRAPH BY ALAN D. LEVENSON

age of nanotechnology will herald a vast array of medical miracles: pills that diagnose and cure almost any disease cell-by-cell surgical repair, and the fabrication of new organs from scratch. As a consequence we can expect life spans in the hundreds, perhaps even thousands, of years. Drexler predicts that his little nanoengines will be able to revive and return to health people who have been frozen in cryonic suspension. The persuasiveness of his case for cryonics has caused people such as Keith Henson, founder of the L-5 Society, a space-activist group, to make arrangements to have themselves frozen at the time of their "deanimation"—the term cryonicists prefer to *death*—or what they call "a more conservative treatment for patients suffering from prolonged cardiac arrest."

Drexler's futuristic views are accepted not only by cryonicists. What's most impressive about nanotechnology—now still in the idea stage—is the rate at which these ideas are being accepted by other researchers. In 1981 Drexler published "Molecular Engineering: An Approach to the Development of General Capabilities for Molecular Manipulation" in the *Proceedings of the National Academy of Sciences*. The audacity of his program prompted others to search for superlatives. Marvin Minsky, more than two years ago in *Omni*, claimed that "nanotechnology could have more effect on our existence than the replacement of sticks and stones by metals and cements and the harnessing of electricity."

Born in Oakland in 1955, Drexler grew up in Monmouth, Oregon. Unfortunately, the nearest decent engineering library was 20 miles away in Corvallis, and as a high-school student he used to ride his bicycle back and forth regularly to get books. His lifelong interest in advanced science and engineering may have been stimulated by his mother, who often read science fiction to him at bedtime. She also kept a scrapbook of clippings on astronomy and spaceflight. The young Drexler never thought much about going into space himself, preferring to conjure up ways that others might do so. His first paper before a scientific audience, given when he was nineteen, was a scheme for manufacturing space colonies out of minerals mined from asteroids.

Drexler got his bachelor's and master's degrees from MIT and was in a doctoral program there until "somehow aeronautics and astronautics seemed to have less interest to me, and I found myself increasingly caught up in nanotechnology." So after he founded the MIT Nanotechnology Study Group, which now meets once a month to monitor the progress and help chart the course of this new technology, Drexler moved to Redwood City, California.

Here he and his wife, Christine Peterson, an MIT chemistry major, founded the Foresight Institute for the purpose of keeping the public in touch with the latest nanotechnological advances. Last spring Drexler gave the world's first university course in nanotechnology at Stanford University, where he's a visiting scholar. He's now at work on a new technical book, *Nanotechnology: Assemblers and Exploratory Engineering*. Packed with graphs, equations, and diagrams, it will present the nuts-and-bolts design work of this emerging technological frontier.

Ed Regis interviewed Drexler over a holiday weekend at Drexler's home in Redwood City. Speaking slowly and deliberately, Drexler sometimes paused for long stretches to picture the fine details of a world that, so far, exists largely within his own neurocircuitry.

***Omni*:** Did your parents regard you as special when you were growing up?

Drexler: If they did, they didn't say so. My parents taught me to read. In elementary school, where they were supposedly teaching us to read using Dick-and-Jane-type books, they'd put us in a circle and have each of us read a sentence. I'd count ahead to see which sentence I'd have to read, so that meanwhile I could read a science-fiction novel.

> *"If a woman can wear a necklace that, when shaken, calls the police and broadcasts a live video of what's going on around her, then certain forms of crime would presumably fail."*

Omni: *Engines of Creation* describes some fairly miraculous feats to be accomplished by nanomachines. Doesn't the so-called meat machine enable you to shovel in some straw and dirt and have a steak pop out?

Drexler: The *cabinet beast*? It's a somewhat fanciful, although feasible, example of what you could do with nanotechnology. Inside itself it would provide just as a cow does accidentally, an environment in which steaks grow. You could make something that is not a cow but that will do likewise. Instead of running off of light and grass, it would run off of electricity. It would sit on a kitchen shelf and let you slice fresh meat from it.

Omni: Of course, nanotechnology will have numerous applications in medicine.

Drexler: Living cells are both constructed and repaired by molecular machines in nature. But nature's repair processes are limited, and many conditions can't be repaired naturally. With nanotechnology-built cell-repair machines that operate under computer control, much more complex sorts of operations will be possible. This will basically bring surgical control to the molecular level—something we've never had before.

Omni: You've also suggested that aspirin-size "pills" containing a variety of nanomachines, would first diagnose any problem a person might have and then make the necessary repairs.

Drexler: Right, but obviously this would require vast amounts of knowledge and very complex software. The pills would contain large numbers of sophisticated devices, including computers and large databases. They'd have more information available for diagnosis than does any physician today, because by then we'd understand the body's structure in so much greater detail. Repair devices would travel through the body much like white blood cells do. Unlike white blood cells, though, they'd examine individual cells, even their interiors, in molecular detail and conduct repairs of those internal structures.

Omni: You claim that nanotechnology will usher in an era of unprecedented material abundance. How?

Drexler: The foundation of nanotechnology will be robotlike molecular assemblers able to build complex structures by assembling molecules. If they are supplied with energy and raw materials, they'd be able to self-replicate, make copies of themselves. Assemblers will be able to build virtually any structure, usually out of cheap raw materials. If you can do this at all, you can do it without the input of human labor because there is no real role for human hands in arranging atoms. It should be possible to take raw materials and convert them into extremely high-quality goods with low material costs, modest energy, and virtually no labor costs.

Omni: Whenever we build something, labor goes into it. Humans or machines *do* something. How are we getting something for nothing?

Drexler: Well, when trees grow the manufacture of that wood does not require human labor. There is a trivial amount of labor, perhaps, in putting the seed there, but maybe the seed got there from a previous tree. The energy comes from the sun, materials from the atmosphere. In a similar fashion, it should be possible to make seeds that, when given the right nutrients, will "grow" to make almost anything physically possible.

Omni: Will nanotechnology be able to make anything we want—cars, boats, custom houses—almost for free?

Drexler: If the neighborhood is zoned for it, yes. Ha-ha.

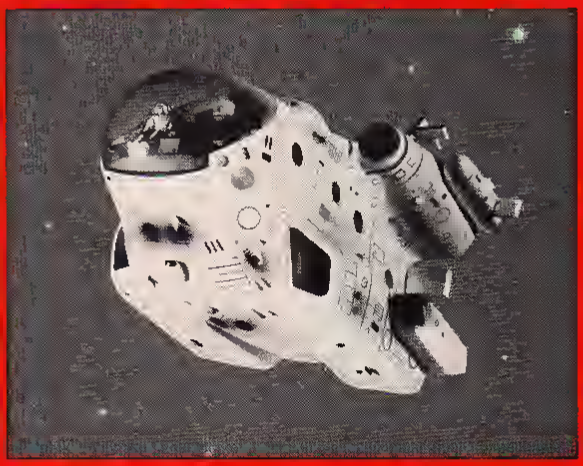
Omni: What do these capabilities mean for cryonics?

Drexler: Nanotechnology will eventually

CONTINUED ON PAGE 104

"Twenty-year-old pilot Frederick Valentich and the Cessna 182L had seemingly vanished in midair."

ANTI-MATTER



UFO UPDATE

"Melbourne that strange aircraft is hovering on top of me again." The engine of the Cessna 182L was coughing as Australian pilot Frederick Valentich, age twenty, released his radio microphone button.

Less than an hour earlier, just before sundown on October 21, 1978, Valentich had taken off from Melbourne and headed toward King Island. His mission: to buy crayfish and accumulate flight hours toward earning his commercial pilot's license. It was a still, almost cloudless evening, perfect weather for the young man's first solo night flight over water. Since banking left off Cape Otway, however, Valentich had reported he was being pursued by a UFO.

"It's a long shape," Valentich told flight controllers, "with a green light" and "sort of metallic-like, all shiny on the outside." Finally, Valentich stopped talking, and for the next 14 seconds, controllers heard a strange metallic ringing sound. Then silence. As the Australian Department of Transportation (ADOT) launched an intensive search-and-rescue effort, the story broke over the wire services.

Physicist Richard Haines first learned of the incident two days later from a front-page story in the Palo Alto *Times*. "I was drawn into this case immediately," recalls Haines, a NASA scientist whose hobby of investigating pilot encounters with UFOs began in the late Sixties. He was especially intrigued because the article had included a transcript of Valentich's voice tape, "evidence either we usually don't have or isn't made available."

That night Haines embarked on his own investigation, one that would consume most of his leisure hours for the next seven years.

Launching into the project, Haines found several public reports of unexplained aerial phenomena in the skies over Cape Otway that night. Amateur photographer Roy Manifold, for instance, produced shots of what looked like a hovering object surrounded by vapor. But, says Haines, "I just wasn't convinced. There wasn't a reflection in the water where I thought there should be one."

Haines also obtained a copy of Valentich's voice tape and conducted exhaustive spectral analyses of the metallic ringing sound heard at the end. "It just gave me goose bumps," he says. "It sounded sort of like empty Coke cans in plastic garbage bags." Nonetheless, Haines and all the sound experts whom he consulted concluded it was "unidentifiable."

In the end, Haines says, he was left with an unsolvable mystery. In an effort to make sense of the incident, his book, entitled *The Melbourne Episode: Case Study of a Missing Pilot* (LDA Press), offers four possible explanations. Valentich became disoriented while flying his plane and finally crashed, he staged a deliberate hoax, he was abducted by the occupants of a UFO, or he was the victim of a top secret U.S. advanced weapons test.

While Haines holds little hope that this case will ever be solved, he's still keeping the irons of inquiry in the fire. "I'm not closing the door on this case," he says. "I'd love to find a solution. I mean, why haven't they found him? It's conceivable that new evidence could emerge." —*A.J.S. RAYL*

SLUG FEST

For starters how about a martini with a slug twist Than, as an appetizer, whole slugs in green Jell-O The main course? Your choice of slughetti or slugaroni And for dessert, a slice of up-slime-down cake These are just a few of the choice morsels you might find at the annual Slug Fest in Monte Rio California It seems that each spring thousands of slimy banana slugs invade the area, and nine years ago the town's local paper decided to do something about it

"We wanted something indigenous, says Tom Richman general manager of a West Sonoma County weekly and organizer of the Slug Fest Now in its tenth year, the fest includes the slug sprint, announced Kentucky Derby-style over a loudspeaker Next comes the superslug contest, where the largest slug is dressed in a purple velvet cape, then carried out on a purple pillow to strains of the theme from *Rocky* The most popular event, however is the slug cuisine contest Contestants create their own slug dishes and according to Richman the judges are mostly politicians "The first time I got the county sheriff to be a judge ' he notes "he sent me a letter and threatened to have me arrested if I ever tried asking him again "

But do the slugs really taste that bad?

'Well I've actually eaten only one," says Richman "It was a chili verde slug and to me it tasted kind of like a gamy escargot To be frank, it's not something I'd like to eat every day

—Rick Boling

DOLPHIN CONFESSIONS

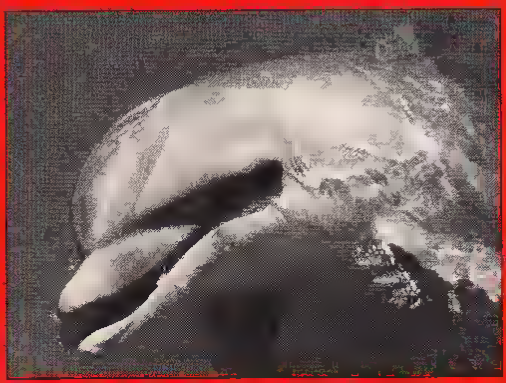
Dolphins have now been recruited in the search for extraterrestrial life Scott Jones director of the Center for Applied Anomalous Phenomena in Falls Church, Virginia is trying to establish telepathic contact with dolphins in the hopes that they will lead him to an unknown underwater object such as a crashed saucer

Jones began his project in 1984 after an experiment indicated that Jan Northup a Washington, DC businesswoman, was communicating telepathically with dolphins in a circular holding pen Last summer Northup and Jones began working with a pod of dolphins in the open ocean If the information exchange was not extensive Jones says it is probably because "we hadn't yet been fully accepted into the pod It appears that we have an apprenticeship to fulfill We did, however manage to outline our research with them and we anticipate working with the pod again "

—Patrick Huyghe

"Time is the substance of which I am made Time is a river that bears me away, but I am the river, it is a tiger that mangles me, but I am the tiger; it is a fire that consumes me, but I am the fire The world, alas, is real, I, alas, am Borges "

—Jorge Luis Borges



THE GOD MUST BE ANGRY

Their religion has been personal to the point of secrecy But some worshipers of Pele the fiery goddess of the Hawaiian volcanoes Mauna Loa and Kilauea, are now emerging to say that their deity is angry over a multimillion-dollar geothermal project drilling holes in Pele's body Their proof? When the project was approved in 1983 Kilauea began erupting monthly and has been doing so daily since July 1986 In all the eruptions have destroyed nearly 60 homes

By going public for the first time since the Christian missionaries forced them underground nearly 200 years ago, the followers of Pele say they have risked social ridicule and the wrath of Pele herself So far they have appealed (unsuccessfully) to the U S Supreme Court and have struck blows at Hawaii s most sacred cow tourism Under the headline COME TO HAWAII—SWIM IN POLLUTED WATER BREATHE TOXIC FUMES SEE UGLY ELECTRIC TOWERS the Pele Defense Fund s advertisements explain religious economic and environmental objections to the geothermal project

"The Judeo-Christian concept says that their God gave them the world to do with as they please " explains Lehua Lopez a worshiper of Pele "But we believe that the world exists on its own and that we are part of it And if we have to destroy one of our gods just so we can have electricity, we would much rather do without

—Rick Boling

BEYOND THE TUNNEL

After a journey through a tunnel, a review of one s life and contact with the deceased the world can seem mundane In fact says Bette Furn, who runs the Partial Hospital Program at St Mary s Hospital in Waterbury Connecticut returning from the near death experience or NDE is the ultimate culture shock '

To help NDE-ers come to grips with the experience she proposes that they tap the same techniques psychologists use to help people understand one another across cultural barriers To start says Furn, the therapist must determine the worldview of the family Once commonalities are found they can be used to help everyone adjust to the change

For the NDE-ers, changes often include increased spirituality and decreased desire for material goods Furn gives an example of the executive who has an NDE and 'then doesn't see achievement as important anymore He may value life more be more loving and caring but earn less money

Fortunately for NDE-ers, Furn intends to put her approach to use "I hope to open a part-time practice and NDE-ers are one target group that I would like to see —Paul McCarthy

OUTCH HEALING

Can the laying on of hands lower blood pressure? After talking to several thousand people who said they felt better after going to psychics, psychologist Sybo Schouten and his colleagues at State University and at University Hospital in Utrecht the Netherlands, decided to take a more systematic look at the phenomenon

The researchers divided 96 people suffering from hypertension into three groups The first group experienced physical contact with psychics the second group sat behind a curtain while psychics tried to lower blood pressure through thought projection, and the third group received no treatment at all Surprisingly, at the end of 15 weeks, all three groups had significantly lowered their systolic and diastolic pressures According to the researchers, the overall fall was probably due to psychological factors or possibly even to the seasonal variability of blood pressure

There is no substantial evidence ' says Schouten ' for the paranormal effect '

—Paul McCarthy

"Healing is a living process, greatly under the influence of mental conditions It has often been found that the same wound received in battle will do well in the soldiers that have beaten, that would prove fatal in those that have just been defeated '

—Oliver Wendell Holmes

FUZZY IMPRESSIONS

Their paintings outraged critics and revolutionized the world of art by giving the general impression of a scene instead of a mass of meticulous detail The offending group became known as the Impressionists and among their leaders was Edgar Degas especially renowned for his pictures of ballet dancers But his style British art historian Richard Kendall now claims may have been due in part to damaged eyesight

According to Kendall the squinting Degas suffered from irregular astigmatism which produces haziness and distortion of the field of vision Indeed when Degas was only forty-three he wrote to a relative that his perception was cloudy Worst of all—and not too widely known says Kendall—is that early in his career Degas lost the sight in his right eye altogether All this, Kendall concludes unavoidably suggests that Degas s eye condition affected his art

Such information would have evoked self congratulatory smirks from the original critics of the Impressionists Many says Kendall sarcastically accused the group of collective eyestrain or eye disease and snorted that Impressionist paintings represented the world as seen through defective vision

Though describing such a dismissal of their work as absurd Kendall admits that several other Impressionists had eye problems, too For instance for the last 20 years of his life Claude Monet had cataracts Because of an ocular infection Camille Pissarro had his eyes bandaged for a long period And by his late forties Degas himself who spurned spectacles was using a magnifying glass

Many of his later characteristics, like the bold massing of forms and lack of precise detail says Kendall "can be seen as a product of his reduced visual acuity Certain other qualities like brilliant colors and aggressively conceived compositions, may represent efforts to compensate for his handicap —Ivor Smullen

' The job of an artist is always to deepen the mystery
—Francis Bacon

ASTROLOGICAL PROJECTION

Have you ever wondered whether astrologers could intuit as much about you as psychologists could? Psychologists Anton DeMan of Bishop's University in Quebec and Huub Angenent of Rijksuniversiteit te Groningen in Holland decided to find out

To do so, they gave the dates and times of birth of 30 subjects to an astrologer Then they asked psychologists who knew the subjects well to agree or disagree with the astrological assessments It turned out that the psychologists agreed with the astrologer s evaluations 73 percent of the time

The authors think this research tells us something about psychological evaluations in general Like astrological appraisals "some of the psychological descriptions are so general that they apply to everybody

Notes DeMan "Perhaps some of the people who believe that psychology is already a science have been overdoing it a little bit '

DeMan would get no argument from psychologist and astrology critic Ray Hyman of the University of Oregon in Eugene Hyman doesn't think that the way DeMan did his study was correct but says, 'Personality tests aren't much different from fortune-telling, so in that sense DeMan and Angenent are probably right "

—Paul McCarthy

"One should only see a psychiatrist out of boredom '
—Muriel Spark

RULES

CONTINUED FROM PAGE 47

and Virginia and the rail complex at Cincinnati On the night of second August, terrorist-planted pressure mines—set so that they would go off only under the weight of a full train—took out the Potomac Bridge and the Cincinnati choke point was severed by use of an expert combination of low-order (ammonium nitrate combined with heating grade fuel oil) and high-order (both C_4 and dynamite) explosives

Rebuilding is under way, but as you read this, the accordion effect, coupled with the fact that power outages make it impossible to pump automotive fuel, promises substantial interruption of freight delivery, especially of food staples, for some time to come

Natural Gas Supply for Industrial, Utility, Commercial, and Residential Use in Northeastern and Atlantic Coastal U S Cut by 75 Percent, Restoration to Take a Year

Seventy-one percent of domestic natural gas is produced in Texas and Louisiana Texas consumes a substantial amount of its own production The remainder is exported interstate via pipelines combining both lengths of pipe and compressor stations Louisiana, by contrast, consumes little of its production the bulk of it combined with excess Texas gas transported from next door, is shipped by pipeline interstate to the northeastern and Atlantic coastal markets Thus the terrorists, by targeting just the key compressors and a few pipeline river crossings (easily identified by large warning signs saying, WARNING—DO NOT ANCHOR—PIPELINE) entirely within the state of Louisiana, caused a catastrophe From Louisiana the pipe network fans out into the Northeast and Atlantic coast The key compressors are in Louisiana at the base of the fan They have no protection at all

As with the EHV transformers, many of the gas compressors were manufactured abroad Replacement lead times are long Very few are in inventory The damaged compressors destroyed easily by Soviet RPG-7 s (rifle-propelled grenades), cannot be repaired Even after gas transmission restoration, it will take nearly a year just to relight the industrial pilot lights in large utility and manufacturing installations

Computer Database Erasure of Wall Street, Six Federal Reserve Banks, Two IRS Service Centers, Several of Largest Commercial Banks, and Numerous Corporations Produces Fiscal Chaos

The same small teams that attacked the EHV transformers serving New York Washington Dallas, Atlanta Boston, Chicago, and San Francisco then used man transportable electromagnetic pulse generators (EMPGs) to erase computer databases in those cities The extent of the havoc is now becoming clear as all but the cash monetary system collapses

A Special Operations Capable Marine Expeditionary Unit (SOCMEU) exercising in Louisiana was alerted by the demolition of a natural gas pipeline af a river crossing By dawn they killed six and captured four from two separate five-man terrorist teams Captured with one team was its EMPG

The EMPG, cruder and more bulky than our own classified device, appears to be of Soviet ongin While both theirs and ours use superconductors, theirs is coupled with an explosion, whereas ours uses an implosion for greater yield

The best minds we have are trying to find ways to reconstruct what was lost through retrieval of partial data from unaffected network components They are working first on the governmental losses

"Experts have been worried about computer viruses for years. The threat is minor compared to EMPG—it erases everything: records of Treasury bonds, VA checks, civilian and military pensions."

It may, for example, be possible through the use of old paper records that may survive in local offices as well as any correspondence in the hands of individual citizens, to reconstruct some of the Social Security system We may, however, have to ask Congress fo consider some sort of postcatastrophic forgiveness or moratorium and a fresh start for some of the private sector

The loss of Social Security records causes the most severe impact on civilians, the government is more devastated by the loss of IRS records Many experts have for years been worried about computer viruses Their threat is minor compared to that of the EMPG which erases everything records of Treasury bonds, VA checks, pension plans military pensions Some military installations are protected from EMPGs, but none of the civilian military ones are such as those installations where records of military pensions are kept

Who Did It and How?

Intelligence community and Department of Defense (DOD) estimates of the total number of terrorists involved in the coordinated attack vary from 100 to 250 We shall not know the exact number for a long time if ever Although the terrorists are being hunted by both the FBI and civil authorities on the theory of criminal law violation, as by DOD Special Warfare (SPECWAR) assets—such as the SEALs, SOCMEU, and the Army's Delta Force—on the theory of military attack and under martial law CIA believes that in the continuing chaos following the assault most participants slipped out of the country, probably via Mexico

Although worldwide there are more than 3 000 terrorists belonging to about 50 organizations, the intelligence community pinpoints only about five groups with a combined membership of about 200 highly trained men and women as being capable of the second August attack While there are different estimates of the number of international terrorist groups, here we are including the PLO IRA (which became totally Marxist, so now there exists the provisional IRA called the Provos which is the majority and socialist), Japanese Red Army, the French Action Directe, the Islamic Jihad Some groups are bogus, like Black September which was created by the PLO so that it could deny its role in the Olympics massacre It is, however, unlikely that they could all be recruited for this operation

Noting that all those captured by the SOCMEU in Louisiana were black aliens, CIA has assigned a high degree of credibility to the information passed on by Mossad that the entire Louisiana attacking force was recruited from black citizens of Communist African nations who were students at the Soviets' Patrice Lumumba University and that the recruits training took place at the same bases that are used to train the PLO as well as other terrorist groups

Mossad advances the foregoing based upon three factors that the attack was Soviet sponsored and directed (CIA is not so sure They like the Qaddafi revenge theory better—that he arranged the attack to avenge the death of his daughter in 1986 when we bombed his palace) that the existing pool of 200 sufficiently trained terrorists could not be recruited en masse for one operation and that groups of blacks could pass unnoticed in Louisiana, given the existing residual racism in the region

This led to the white commanding officers ignoring the input of competent black police in the South who detected the presence of black aliens immediately and submitted their field intelligence reports on this matter—the typical police operations procedure (FBI records tend to lend support to this theory According to reports from the New Orleans field office black police officers in Louisiana picked up rumors of strange blacks moving about but when they reported them to their white superiors they were either

ridiculed or completely ignored.)

It is the consensus, therefore, that the terrorists were recruited from among the 200 who constitute the transnational threat, further supplemented by a contingent of trained-for-the-event Communist black Africans.

The Soviet initiation theory is lent credence by the possession of the EMPG devices. Other than us, only the Soviets are known to have them, and although Israel could probably build one, it would most likely employ our implosion/superconductor technology rather than that of the cruder, less efficient Soviet model.

DARPA suggests Soviet responsibility based not only on the EMPG technology but also on the captured communications equipment. It nearly mirrors our latest classified gear but with construction techniques peculiarly Soviet. The transceivers operate using a constant sweep of an exceptionally large number of frequencies so that no one frequency is used for more than a microsecond at a time, rendering effective interception virtually impossible. Both Israel and Switzerland have equipment operating on the same principle. We have acquired specimens of both, and the transceivers in question are definitely neither.

The question of responsibility remains in doubt. In view of the foregoing, CIA avers that only the black Africans can be believed to have acted from ideological conviction. International terrorists are really, regardless of their rhetoric, not ideological, despite undistributed extreme left or right dispositions. They do it for personal, psychosocial reasons—because they "like" it.

The how of it is relatively simple. The terrorists were outfitted with appropriate clothing, alias documentation, and pocket litter and infiltrated into the nation with the most porous border on Earth. Armament in total (including AK-47 assault rifles, RPG-7's, handguns, ammunition, and miscellaneous mines and other ordnance) amounted to a small mass compared with the bulk of such regularly smuggled contraband as marijuana. All the odd laws we passed against "plastic" guns did nothing to halt the march of technology, specifically the production of plastic polymer and ceramic guns. While weapons made of these materials are a bit delicate for use in traditional hand-to-hand fashion—i.e., to strike the enemy with—ceramic/plastic construction offers a number of benefits. Ceramic/polymer weapons are impervious to rust, extreme heat, and the elements, and they are self-cleaning.

What we have accomplished with our restrictive laws on this technology was to lose a large new industry and all the jobs that go with it. Even without resorting to such high-tech weapons, it is relatively straightforward to get a standard-construction gun through the airport magnetometers and roentgen machines, which are a joke. In a previous terrorist attack on an aircraft, for example, the protagonists took a common semiautomatic pistol apart and immersed its pieces in molten leaded crystal. This passed as an opaque object through the airport machines. Once airborne, one of the terrorists went into the plane's bathroom, broke the glass, and reassembled the pistol. There is no substitute for human inspection by trained personnel.

Which leaves the question of why. To understand that requires a recapitulation of what has been done to us, what has been accomplished from the point of view of whoever was behind the attack.

Our biggest cities and the huge areas surrounding them (the Boston/New York/Baltimore/Washington metropolitan areas interconnect) are without electrical power, have been so for a month, and will continue to be so for many more. Food has spoiled because there is no refrigeration. (Gas-powered refrigerators have run out.) Fuel cannot be pumped. What traffic there is is gridlocked because there are no operational traffic signals.

Garbage is piled up. Rats are running rampant. Emergency generators at hospitals are out of fuel, and the hospitals are running out of supplies. Freight cannot be moved. Factories are out of operation. Food produced in relatively unaffected areas cannot be marketed or even effectively distributed as relief in the affected areas—because there is no electricity, and combustion engines need fuel. Police, mistakenly now wedded to and dependent upon the automobile, are crippled. The people, weaned on what passes for news on television and radio, are without it.

Virtually every citizen in the vast areas affected by the attack is now jobless because factories have no fuel or power. The homes in the North are without heat and light, with winter coming on. The economy as we know it is at a halt, and the banking system is shut down. Denied such basics of civilization as police, fire, and health care, people are frantic. They have looked to Washington, and Washington has been able to do nothing. We cannot even communicate effectively with these people. Even battery-powered portable radios are failing as their batteries give out.

As you know, according to Kuppermann and other observers, the "prayer" of public officials has always been that a disaster will be either so immense as to be perceived as an "act of God" and thus engage the loyalty and team spirit of both the government and a patient populace or so small that it will go away by itself. The dread of officials is the one in between, affecting more than one choke point the one with which government cannot cope. It is dreaded because it damages the faith of the people in their government and way of life.

The current situation is a nightmare. The

people know this was not an act of God What has happened is so immense as to be almost incomprehensible to them The people expect their government to do something about it, to fix the problem and punish those responsible And the American people are not patient Their faith in what the Founding Fathers wrought is ebbing fast It is this last factor that occasioned the following

The Capitol Hill Riot

DOD, working with the Secret Service, has taken elaborate precautions to protect the White House from the angry mobs that looted and burned the K Street corridor The service has taken additional steps to protect the White House This is beyond the work that has been done in past years, including the concrete barriers and extensive sensor deployment As you are aware if a would-be intruder stood in Lafayette Park and lonked at the executive mansion, he would be observed via high-powered TV monitors secreted in the little vent housings on the roof of the White House Beyond this, should an individual set foot anywhere on the lawn area, sensors would display exactly where he or she was Should evacuation become necessary for you or members of your staff there is the escape tunnel from the White House into the Treasury—which has been recently checked and is fully operational It was anticipated that the focus of resentment would be upon your office and the White House the symbol of authority of the national government throughout our history We know now that that has changed

Gradually, over the past few administrations, as Congress passed law after law for the people and the executive branch to follow but excepted Congress itself (the civil rights acts, the Fair Labor Standards Act, the minimum wage laws, etc.) and as Congress continued to act as if the rest of the laws of the land did not apply to its members (and indeed the Constitution itself, as Congress usurped more and more of the powers of the executive branch) the perception of the people shifted like the needle of a compass toward a more powerful magnet The Capitol building came to supplant the White House as the foremost symbol of power as well as the actual locus of power

Thus the rage and frustration of the people was not directed at you but at Congress Speaker of the House Galloway, bravely defying the urgent advice of the Capitol police, sought to confront and calm the mob sacking the Capitol building and beating individual members The mob, shouting obscenities and references to the speaker's recent press conference—at which he denied new charges of illegality in his solicitation of campaign contributions—used electrical cable from a nearby construction repair site to hang him from a lamppost

Action

We have got to reunite the country without delay Already for millions their faith in government and our way of life has been destroyed We can keep that from happening to the majority of the population The present situation serves as an opportunity to do that and to achieve the return of power to the presidency As a bonus, we can be rid of Communist Nicaragua The armed forces are intact and functioning A quick strike by all three divisions of the Marine Corps (the Army will scream but we need them here to deal with the emergency) will get rid of the *comandantes* within 90 days It will focus the public's attention outside and let us get a handle on things domestic This recommendation is concurred in by all of your Cabinet save the Department of State

The aim of this action is to divert the country from its domestic woes This is a perfect job for the Marines—it is the sort of mission that they are intended to perform The general plan of battle is for one division to land via amphibious assault on Nicaragua's Atlantic coast, and another on the Pacific side with a third division in reserve The division landing on the Pacific coast would capture Managua. The Sandinistas are expected to take to the countryside The two divisions would then employ a classic pincer movement to trap the Nicaraguan forces between them

The legal scenario that such action would prompt is as follows Congress passed the War Powers Act, to which no President has yet yielded Nor has any President tested it, either legally or politically The legal test for those opposed to this act centers on the theory that if you read it together with the decision of the Supreme Court that struck down the congressional veto, then the War Powers Act is unconstitutional and thus can be ignored by the President In short, we could just do it and then tell those against our action to take us to court Strategically, from a legal point of view it is important to note also that because Nicaragua is small, if you use overwhelming power and get the job done and the U.S. troops out within 90 days, the War Powers Act never goes into effect, and the point is moot

"Delay in the use of force, and hesitation to accept responsibility for its employment when the situation clearly demands it, will always be interpreted as a weakness Such indecision will encourage further disorder, and will eventually necessitate measures more severe than those which would have sufficed in the first instance."—*The United States Marine Corps Small Wars Manual* (1940), page 27, paragraph (d)

Your father and any other veteran of WWII would remember

APPROVE ___ DISAPPROVE ___ ∞

SPACE

CONTINUED FROM PAGE 26

complaints—even to Congress—that NASA was picking mediocre insiders while leaving the cream of American academe out of the corps There has been much less science on the shuttle, however, than originally anticipated In addition, scientifically oriented astronauts have a hard time staying current in their specialties so that they can remain top-flight researchers or physicians while training full-time to go into space NASA acknowledges this problem According to Dan Brandenstein, chief of the Astronaut Office, projects and accommodations to let researchers keep up their professional proficiency have to be "on a limited basis I can't run the Astronaut Office with twenty percent of the people gone six months of the time"

And for all this effort what will the Nineties astronauts get to do? They can expect to fly only a few times in their career Those who get the top prize—space station duty—will spend long hours of EVA (extravehicular activity) constructing their homes away from home—then tedious months living in them

Their future jobs may require astronauts to undergo more rigorous psychological evaluations than did past classes According to NASA research physician Patricia Santy, the agency is developing criteria to measure an astronaut's "sensitivity to self and others, motivation, and suitedness to task." This assessment will be vital in putting together a crew able to live months in tight quarters while performing routine, demanding tasks

But even for those candidates who dutifully "fill in all the boxes" there are factors that can alter the makeup of the corps "There's always a political element in selection," says one astronaut hopeful "elements beyond my control that can shoot down my chances." ∞

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FORUM

CONTINUED FROM PAGE 22

Enormous effort and attention have been thrown toward AIDS research, and the information we gain is going to help us on other fronts. The AIDS virus [human immunodeficiency virus, or HIV] has significantly increased the statistical chances for an amazing discovery.

HIV has some very interesting capabilities. It inserts itself into the host cell and then is seemingly quiescent, for example. How and why does it do that? What turns it on? The answers are going to provide an enormous leap forward. We are already very close to something equivalent to the sudden realization of the stereoscopic shape of the DNA molecule, a landmark discovery that subsequently led to many different avenues of research and answers.

Joyce Thompson, *author of* The Blue Chair, Conscience Place and East Is West of Here

First of all, some quick and dirty prognostications. By the year 2000, the world's currency will be backed not by the traditional precious metals but by gallium arsenide or whatever is its successor as the medium of choice for computer chip architecture. The Electoral College will be rightfully replaced by the media college, which will elect the president and vice president. And a video game decathlon will become an officially sanctioned Olympic event.

I believe, seriously, that video games are going to deal Christian mythology its greatest blow. Most of today's popular video games are based on the quest mythologies [a search for a great treasure or for an ultimate truth] of many different times and many different sources. The guys who are writing Nintendo's *Kid Icarus* and other games are already into classical mythology.

The fact that a kid can choose among any one of 30 worlds, plug into it, and interact with it is inevitably going to make any established religion or philosophy absolutely irrelevant. They'll want to influence the course of events with a control pad in their hands and, in fact, will have learned that they can within 30 different ideologic systems by the time they're ten years old. This will create a big problem for long-held belief systems. The games make them seem pretty dull.

We will see interactive video games that replicate Buddhism's seven stages of enlightenment. You'll be able to experience Dante's trip through the inferno, the six ascending chakras of kundalini yoga. And today's young video game designers will become our new priests.

Sound recorded by Cyrano de Bergerac, cites portable possibilities

"As I opened the Box, I found within somewhat of Metal, almost like to our Clocks full of I know not what little Springs and imperceptibla Engines. It was a Book, indeed; but a Strange and Wonderful Book, that had neither Leaves nor Letters. So that when any Body has a mind to read in it, he winds up that machine with a great many Strings, then he turns the Hand to the Chapter which he desires to hear, and straight, as from the Mouth of a Man, or a Musical Instrument, proceed all the distinct and different Sounds, which the *Lunar* Grandees make use of for expressing their Thoughts, instead of Language.

'They are never without Lecturas, in their Chambers, their Walks, the Town, or Travelling: they may have in their Pockets, or at their Girdles, Thirty of these Books, where they need but wind up a Spring to hear a whole Chapter. This Present employed me about an hour; and then hanging them to my Ears, like a pair of Pendants, I went a Walking."—*The Comical History of the Moon*, 1657

1898. First rudimentary tape recorder, using magnetized steel wire to store electronic sound signals.

1988. The Walkman is a common consumer product, audio books are increasingly popular.

Pat Cadigan, *author of* Mindplayers *and "Patterns"* (Omni, *August 1987*)

There are already a few cases of brain implants that can control manic depression caused by a chemical imbalance. People prone to manic depression will have an implant that would be manually controlled. When the implanted warning system detects a deviation in brain chemistry, it will sound a kind of alarm in a hand-held unit. The patient will then press the appropriate button or controls to affect the chemical imbalance. It's possible that such implants will also control epilepsy and psychotic episodes, for example. If nanotechnology [the ability to manufacture goods on the microscopic level] were developed enough by 1999, of course, the minute implant would contain all the necessary information to operate automatically without the need for hand-held units.

Another possible area of development is the pocket-size computer that uses compact disks [CDs]. The CD will contain an awful lot of information much more than a floppy disk can now. What is now available in a desk-top computer once filled a whole room. Eventually we will be able to carry around all the information contained in a public library. Of course, by 1999 we might be able to carry only one room of the library—we'll need five CDs to hold the whole library.

H. G. Wells reports video recordings will be wave of the future

"He observed one entire side of the outer room was set with rows of peculiar double cylinders inscribed with green lettering on white, and in the centre of this side projected a little apparatus about a yard square and having a white smooth face to the room. He had a transitory idea that these cylinders might be books, or a modern substitute for books. He turned to the square apparatus and examined it. He opened a sort of lid and found one of the double cylinders within, and on the upper edge a little stud like the stud of an electric bell. He pressed this and a rapid clicking began and ceased. He became aware of voices and music, and noticed a play of colour on the smooth front face.

"On the flat surface was now a little picture, very vividly coloured, and in this picture were figures that moved. They were conversing in clear small voices. It was exactly like reality viewed through an inverted opera glass and heard through a long tube."

—*When the Sleeper Wakes*, 1899

April 7, 1927. Secretary of Commerce Herbert Hoover delivers first "long-distance" televised speech.

September 11, 1928. First TV drama *The Queen's Messenger*, broadcast.

1975. VCRs commercially introduced.

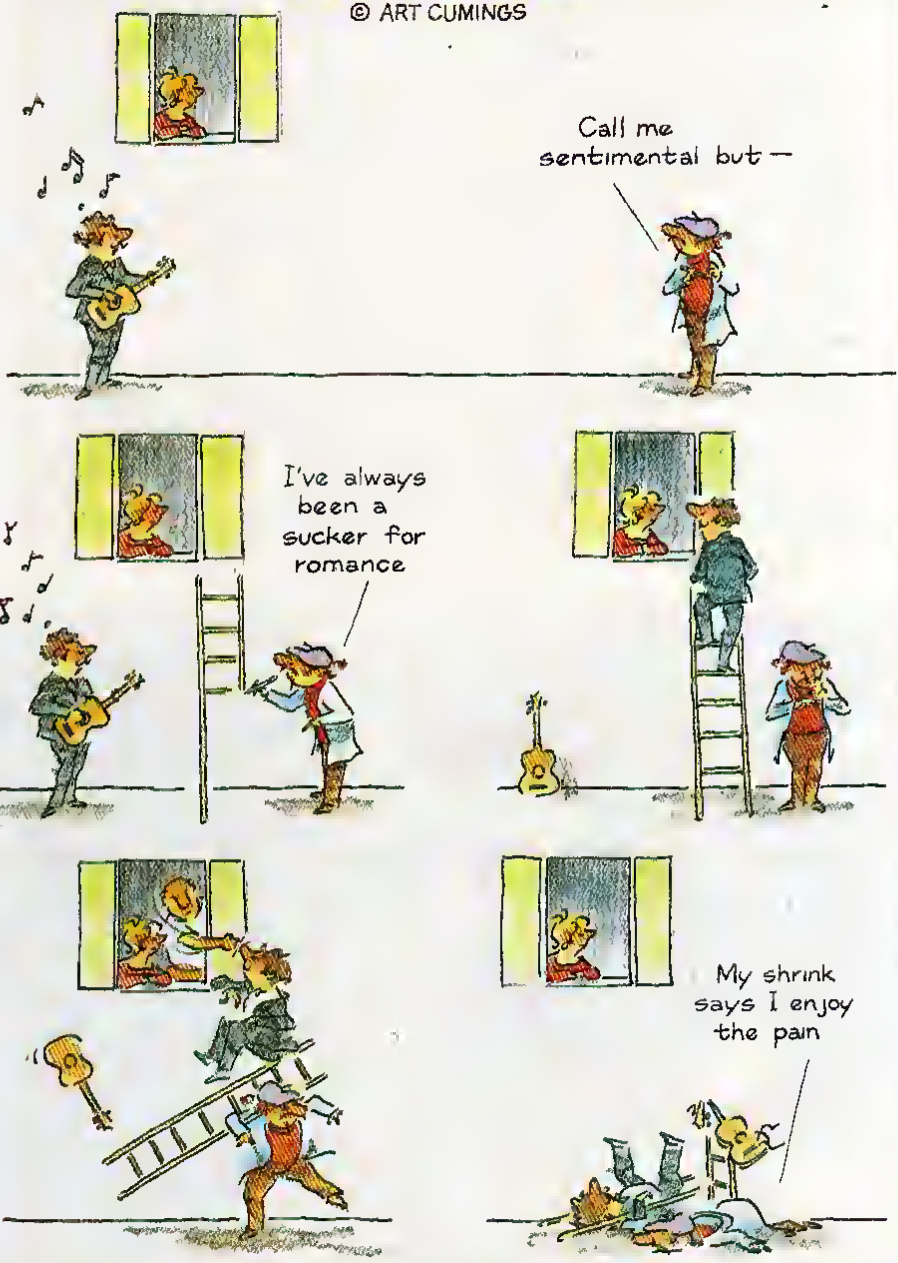
Dan Simmons, *a former educator and author of* Song of Kali *and the short story "Two Minutes Forty-five Seconds"* (Omni, *April 1988*)

I once thought that in the early to mid-Nineties, we would see the breakdown of the school system, the rise of corporate academies, the voucher system for tuition, and so forth. But now I don't know what will happen with the education system except that computers probably won't be a big part of it.

I expected that educators would use information-retrieval systems in education to split their time between the handling of information—which the machines can do a lot better than human teachers—and socializing students in interpersonal training groups, survival skills groups, and simply trying to turn them into basic human beings. All the other institutions—family, church, and so forth—will be more or less abdicating in the Nineties. I see that happening in the education system more and more—everything from AIDS education to attempts to minimally socialize kids. Since it takes up so much time, it will be nice if the functions of information processing and socialization are separated.

I do see a tremendous potential for a renaissance in space. It's close to a cliché, but my feeling is that what will happen with the American space pro-

The Artist



gram will be similar to what happened with the North and South poles. And some 40 years after the initial rush to plant the flag, there will be a joint scientific and exploratory endeavor.

Life in orbit hailed by Edward Everett Hale

"The plan was this. If from the surface of the earth, by a gigantic peashooter you could shoot a pea upward from Greenwich, aimed northward as well as upward, if you drove it so fast and far that when its power of ascent was exhausted, and it began to fall, it should clear the earth, and pass outside the North Pole, if you had given it sufficient power to get it half round the earth without touching, that pea would clear the earth forever. It would continue to rotate above the North Pole, above the Feejee Island place above the South Pole and Greenwich, forever, with the impulse with which it had first cleared our atmosphere and attraction.

"At the least it must be very substantial. It must stand fire very well. Iron will not answer. It must be brick; we must have a Brick Moon.

"Could it be possible? It was possible! Orcutt and Brannan and the rest of them had survived that giddy flight through the ether and were going and coming on the surface of their own little world. They had three acres of surface, and there were but 37 of them. Not so much crowded as people are in Roxbury, not nearly so much as in Boston."—*The Brick Moon*, 1871

October 1957: *Sputnik* launched.

1973: NASA launches *Skylab*, manned by three separate flight crews for a total of 171 days.

1986: The Soviet Union launches the *Mir* space station.

David Brin, *Hugo and Nebula award-winning author of* Earth, Startide Rising, *and its sequel* The Uplift War

In science fiction, there's been all this youth—the street finding its own uses for technology. But it occurred to me that if you take a street scene in the future, it won't be the young people carrying around the high-tech electronics, it'll be the old people. They might carry around that old camera or radar or something that will record everything in real time and send it home. The effect on crime will be rather impressive. Every person who carries all these things will be a member of a neighborhood watch, at all times.

Nuclear power plant employees emphasize safety, says Robert Heinlein

"Maybe he was wrong in thinking that Harper had at last broken under the strain of tending the most dangerous machine in the world—an atomic power plant. But if he had made a mistake, it had to be on the safe side—slips *must not happen* in this business; not when a slip might result in the atomic detonation of two and a half tons of uranium.

"And each atomic engineer knew it, knew that he gambled not only with his own life, but with the lives of countless others, perhaps the lives of every human being on the planet. Nobody knew quite what such an explosion would do. The most conservative estimate assumed that, in addition to destroying the plant and its personnel completely, it would tear a chunk out of the populous and heavily traveled Los Angeles–Oklahoma Road City a hundred miles to the north."

—*Blowups Happen*, 1940

1942: First artificial self-maintaining nuclear chain reaction induced at University of Chicago.

1957: First large scale nuclear power plant generates electricity in Shippingport, Pennsylvania.

Jack Williamson, *author of* Land's End, *in collaboration with Frederik Pohl:* Lifeburst, *and numerous other works during his 60-year career*

The exciting thing about the future is that it is completely unpredictable, so there is always a possibility of wild cards coming up. We can forecast trends, but the exciting things are those that aren't anticipated by science fiction writers or anybody else.

Only a few years ago, for example, we felt that the absolute limit for superconductors was something like 10° Kelvin. Now it's possible we might get it as high as room temperature. If we succeed in doing that, it will bring about all sorts of technological miracles.

If we develop superconductors, there's a long list of possible applications. We'll have superfast computers, for example, with Cray capacity in a personal computer. There'll be nearly 100 percent efficient, cost-free power available, so it won't matter where power plants are located—they will be somewhere out in the desert. Automobiles will have superconducting magnets that will store power, providing a different means of propulsion. And there'll be levitating trains, essentially friction-free transportation.

Martian moons observed by select astronomers, reports Jonathan Swift

"They have likewise discovered two lesser stars or satellites, which revolve about Mars, whereof the innermost is distant from the centre of the primary planet exactly three of the diameters, and the outermost five, the former revolves in the space of ten hours, and the latter in twenty one and an half; so that the squares of their periodical times are very near in the same proportion with the cubes of their distance from the center of Mars, which evidently shows them to be governed by the same law of gravitation, that influences the other heavenly bodies."—*Gulliver's Travels*, 1726

1877: Asaph Hall discovers Mars' two moons, one orbiting the red planet in about 7.5 hours, the other in 30.3 hours.

Greg Bear, *author of* Blood Music *and* Eon, *as well as the award winning short story "Tangents" (*Omni, *January 1986)*

We can't expect extraordinary changes in the remaining years of the next decade, but I think we can see straight-line development. We will, for example, probably have a complete understanding of the human genome. And knowing how the genome expresses itself, we will learn how to manipulate and change the human body and mind. We'll have a key to the technological evolution of the human body. Evolution will be within our control, and we won't have to wait tens or hundreds of thousands of years. We'll be able to do it in months. So probably by 1999, we will have to face the ethical question of just what is a human being and what are the ethical limits of creating new types of human beings.

Gregory Benford, *author of* Timescape *and* Great Sky River

There will be a technological band saying, "Let's manage Gaia the Earth Mother better." And an apocalyptic band will be saying, "Let's throw ourselves on the mercy of the environment." The two groups will collide.

We have to have some deep emotional agreement about the nature and interrelatedness of our problems before we begin to hack out a solution. But there will be powerful forces arguing against it, precisely because they will anticipate that it means the end of the nation-state, a principal method of large-scale human organization in the last five or six centuries. In that regard, scientists, who have had a genuinely international community for almost a century, will play a leading role. They will serve as early-warning stationmasters and as the problem solvers, while the religious leaders will essentially drum up the crowd.

Sportscaster Hugo Gernsback declares night games possible

"All the great baseball, tennis, and football contests are held after sundown. The reason is apparent. During the daytime, with the sun shining, there is always one team which has an advantage over the other, on account of the light being in their eyes. In the evening, however, with the powerful stationary light overhead, each team has the same condition and the game can be played more fairly and more accurately."—*Ralph 124C 41+: A Romance of the Year 2660*, 1925

1935: Night baseball introduced.

Lewis Shiner, *author of* Deserted Cities of the Heart *as well as "Rebels" (*Omni, *November 1987) and other stories*

I think that by 1999 we're going to find a lot of bartering, underground economies, guerrilla capitalism, fake IDs, serious tax evasion. People will be relying on their friends, people they know, to provide services for which they can exchange their own specialties. People will probably be living pretty much sequestered in their own homes and be able to do so through home shopping clubs. As a consequence, we'll see merchandise like steel doors and shutters that will—at least psychologically, if not physically—enable us to shut out the world and make the home more of a castle.

Isaac Asimov puts calculating computer in his pocket

"The congressman took out his pocket computer, nudged the milled edges twice, looked at its face as it lay there in the palm of his hand, and put it back. [The general] took out his own computer (a severely styled GI model) and struck it at random. 'Make a five seven three eight on the paper.' 'That's five thousand seven hundred and thirty-eight.' . . . Now, (more punching of his computer), seven two three nine. Seven thousand two hundred and thirty-nine."

"He pushed the multiplication contact on his computer and let the numbers whirl to a halt."—"The Feeling of Power," 1957

1971: Pocket calculators replace slide rules—commercially available in the United States for about $400.

1973: Programmable calculators commercially introduced.

Isaac Asimov, *credited with more than 300 published books, the most recent being* Prelude to Foundation

I see at least one great change that is now in the process of developing. Increasing computerization and robotization are going to decentralize the world. The fields will allow everybody to absorb and retain information while passing on the three classifications of undesirable labor—the dull, the dirty, and the dangerous—to robots and computers. This will give us more time for more creative endeavors. The development of an educational system will also use computerization to encourage creativity and make learning a pleasant experience.

Ray Bradbury, *author of* Fahrenheit 451, *"Trap Door" (*Omni, *April 1985), and numerous other works*

In the next 12 years, all our concepts of filmmaking are going to be torn apart and put back together as a result of the videocassette revolution. The traditional movie theater is going to be destroyed and rebuilt. We will stay home with our own video sets, our own popcorn, our own hot dogs, our own friends.

As a result of the video camera, the growth of young directors and filmmakers will be prodigious. We'll have a complete turnover in the cinematic industry between now and the end of the century. Studio bosses' clutches on worthwhile projects will be loosened because of competition from home sets. ☐

EXPLORATIONS

CONTINUED FROM PAGE 31

resource specialist Andrew Gomolak of New Mexico's State Land Office. "This kind of thing is most certainly culture theft. Both the public and our descendants are being ripped off."

According to Edmund Ladd, curator of ethnology at Santa Fe's Museum of Indian Arts and Culture, pothunting robs pueblos of important data about the history of Native Americans, including basic artifacts and ceremonious rituals. "The destruction of information, the history of our country, is far more serious than the destruction of the objects themselves."

Ladd, who is himself a Zuni, doesn't believe the pueblo ruins should be cordoned off with access limited only to Native Americans. "They aren't the most sacred sites, but they should be treated with some respect," he says. "When pothunters desecrate graves, they don't rebury the bones, which are just left scattered around. That is ghoulish and abhorrent."

But the tribes have no control over ruins that aren't located on Indian reservations. "It's the responsibility of government agencies to protect them," Ladd says. He acknowledges, however, that short of assigning full-time guards to the sites, there is no way for anyone to offer complete protection.

Pothunters will often negotiate with landowners to dig up archaeological sites on private land for a fee or a share in the sale of artifacts. To combat the loss of such treasures, the Archaeological Conservancy has purchased parcels of land containing a number of Southwestern pueblos. Landowners sometimes even donate their pueblo property to the private, nonprofit organization, which is based in Santa Fe.

Digging and removing objects on public land, of course, is illegal without proper permits. It doesn't matter whether such sites include ruins or any other indications of human activity. Yet it surprises most people that even if an arrowhead, for example, is found lying on the ground, it's not necessarily up for grabs.

"The most important means of protecting archaeological sites is public education to elicit people's support," Gomolak says. Strengthened enforcement programs and the increased presence of officials at archaeological sites would also deter vandalism.

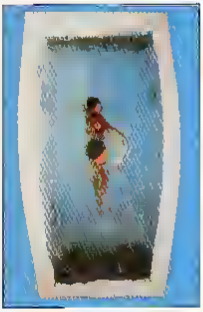
Even so, says Assistant Regional Archaeologist David Gillio of the Forest Service, "the protection of archaeological sites is a lot like guarding the country's borders against the entry of illegal aliens. The government, he points out, makes every effort to prevent aliens from crossing an imaginary line drawn in the dirt, but illegal entry still occurs. And on more than twenty million acres of land in New Mexico alone, the chances of random illegal lootings are infinite. OMNI

STAR TECH

ACCESSING THE FUTURE

SKYCYCLE

This 306-pound, kit-assembled personal gyroplane, the Daki 530Z/IKENGA, is a rotary-wing cousin to a helicopter. It cruises at 93 mph, climbs 1,400 feet per minute, has a ceiling of 14,500 feet and a range of 315 nautical miles. Options include two-seater, full-body enclosure and equipment pods—for crop spraying and surveillance equipment. Price: $10,000. Contact: Gyro 2000, Santa Fe, NM, (505) 988-7188.

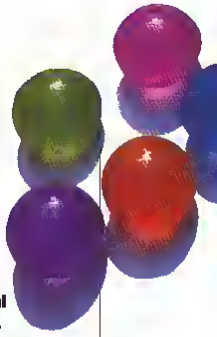


LAP OF LUXURY

Swim laps in a 12- by 6- by 4-foot minipool that works like a treadmill—thanks to its adjustable water current. Price: $19,950. Contact: SwimEx Systems, Warren, RI, (401) 245-1200.

MENTAL BLOCKS

Googolplex geometric building system permits the construction of forms, from simple pyramids to complex spheres composed of pentagons, triangles, squares, and other shapes. Price: $40 to $50 a set. Contact: Arlington-Hews, Inc., Vancouver, Canada, (604) 273-2200.

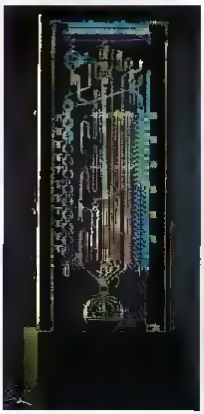


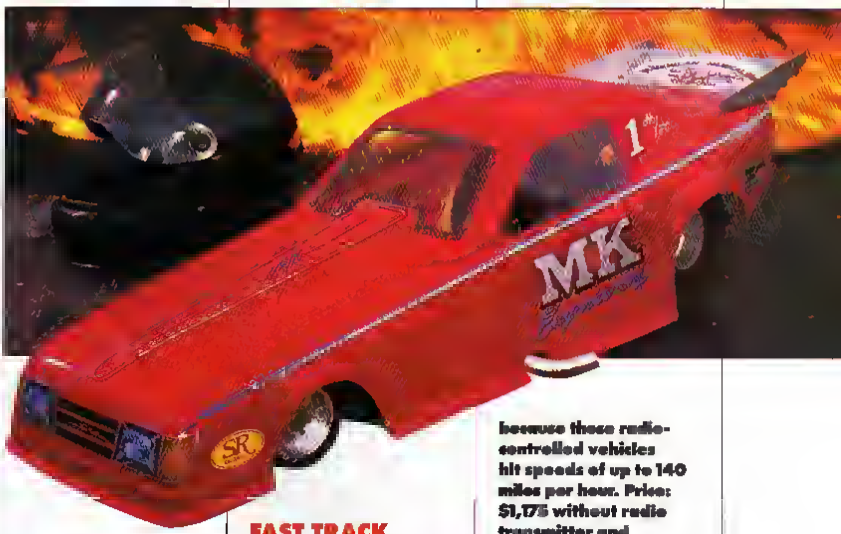
SMART BALL

Squeeze and twist these Glue balls into any shape and they'll return to their original spherical form. Price: $5.25 per set plus $3 for shipping. Contact: Exploratorium Store, San Francisco, (415) 561-0390.

RIVER OF TIME

This clock measures time by the gentle flow of fluid through glass columns and pipes. Price: $65,000 to $495,000, depending on size. Contact: Futura Designs, New York, (212) 228-0392.





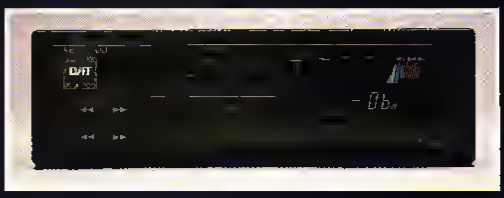
FAST TRACK

One sixth the size of real cars, these true-to-life nitromethane-powered racers (above) leave their electric-motor cousins in the dust. They are machined and built to look and act like full-size dragsters and funny cars, which is a good thing, because these radio-controlled vehicles hit speeds of up to 140 miles per hour. Price: $1,175 without radio transmitter and receiver. Contact: M. K. Engineering, Bay Shore, NY, (516) 242-4641.

The pages in next month's issue could lead you to even greater riches, but first you'll have to decipher our clues in

THE GREAT OMNI TREASURE HUNT

Follow our clues in the February 1989 issue of *Omni* and you could be the proud winner of a 1989 Jeep Wrangler Islander, the grand prize in the fourth annual Great *Omni* Treasure Hunt. You might sail off on Kawasaki's Jet Mate, the party platform valued at more than $5,000 and versatile enough to take you swimming, sight-seeing, sunning, fishing, or diving in your local lake, river, or ocean. You could end up listening to your favorite recordings on Kenwood's $2,500 KDT-996 digital audiotape deck and tuner with wireless remote control. Or you could fly to Puerto Rico, Jamaica, or another Resort Condominium International Caribbean destination and spend a week in a tropical bacchanalian island paradise, complete with lodging, courtesy of *Endless Vacation* magazine. There are plenty more treasures to be found in the pages of *Omni*. For all the details—including the clues and the official rules—in the Great *Omni* Treasure Hunt, look for the February issue, your gateway to a bounty of booty for body, mind, and soul DO



Athlete's feat: The art and science of good sportsmanship

GAMES

With my fingers wedged into fissures barely an inch wide, I hug an almost sheer rock face. My hands scrabble for the next hold—a dimple, a crevice, a furrow, anything to prevent my falling. I'm climbing with no equipment other than my own two hands—no ropes and no pitons to pound into the rock, nothing that an experienced mountain climber would use for support.

Inching along, I approach a curved overhang. I avoid looking down.

Suddenly I slip and fall, resisting the urge to scream. Luckily, the ground is only ten inches away. I land on Astro Turf, my neck intact, only my ego bruised.

This "rock face" is not a mountain in the Rockies but an interactive exhibit called "Climb the Wall" at the Ontario Science Centre in Toronto. Little more than spray-painted gray concrete on steel frames and wire mesh, the rock face runs about 20 feet long and 12 feet high. All day long, kids and adults maneuver, crablike, along the surface to experience the simulated sensation of rock climbing.

Open since last July, the center's $3 million Sport exhibition has more than 20 interactive activities, all based on the premise that behind every athletic event is a scientific concept or natural law.

Say, for example, you want to throw a football with a perfect spiraling motion. At Sport you learn that a spiral rotates along the ball's longitudinal axis. The football cuts through wind resistance to fly farther and more accurately than a ball that wobbles in flight.

At the exhibition you can throw a karate chop into a red cushion and measure your hand speed, or steer a shuddering bobsled in front of a screen that shows the course passing by at 60 miles per hour. Volunteers who pass a basic fitness test can run on a treadmill wearing a snorkellike mouthpiece and electrodes on their chests as the equipment electronically registers their VO_2 max (oxygen uptake).

A shopping-mall-size museum set in a densely wooded ravine, the Ontario Science Centre puts a premium on hands-on involvement for more than 1 million visitors annually.

LET THE GAMES BEGIN

As you enter Sport's long corridor, you hear fans cheering over the loudspeakers, as if you were approaching center court at Wimbledon or pinch-hitting in the World Series. Then you enter the Great Hall, a round, brightly lit room with high ceilings.

In "Land Like a Cat," you step onto a platform that automatically weighs you. Then you leap onto a weight scale that measures your impact. To land softly—a crucial skill for skiers, skaters, and gymnasts—the exhibit explains that you should evenly distribute your weight, squat deeply as you land, and rely on your knees as shock absorbers. The computer

flashes a graph of the force and duration of your landing and then presents you with a readout. If you land with, say, 2.5 times your body weight or less, you will hear the recorded cheers of spectators.

Next, pit yourself in a ten-meter sprint against Angella Issajenko, Canada's fastest female sprinter, who covers the stretch in two seconds flat. You take your place at the starting line and push a button. A voice says, "On your mark... get set... go!" A pistol goes off, and you peel out. A wall alongside the track shows Issajenko in life-size photos at each stage of the run.

In sprinting, you should keep your arms and knees bent because moving a straight limb takes three times as much muscular effort as moving a bent one.

As you run, the Issajenko photos are backlit in sequence at a two-second pace. A scoreboard in-

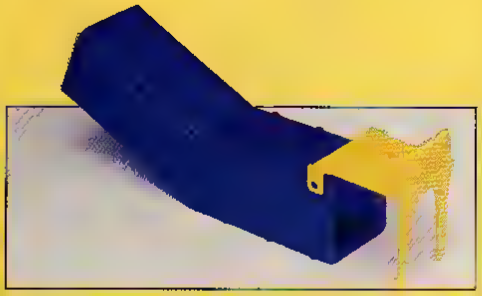
stantly flashes your time—the average being about 3.2 seconds. Only those who jump the gun have a prayer of beating Issajenko.

You can stop at the pitching range, too, if only to see just how much mustard you can get on your fastball. The narrow, net-enclosed range has major-league dimensions: a pitching mound that's 15 inches high and 60 feet, 6 inches from home plate.

When throwing, maintain your balance, rear back for additional leverage, and throw with your whole body. In other words, go into your windup, kick your front leg high, and whip that sucker hard.

A radar gun registers the velocity of your pitch, and the computer provides a digital readout. Major-league pitchers can throw fastballs at a speed of 90 miles per hour, with great accuracy. Sport visitors, however, rarely approach 70 miles per hour or even the strike zone.

An Ontario Science Centre study ten years ago indicating that few sports enthusiasts visited the museum spawned the idea of the Sport exhibition. In 1985 George Vanderkuur, chief scientist at the center and a competitive cyclist,



began seriously brainstorming for ideas with senior designer Tony Gerritsen, a former athlete. "We wanted to show that in the most ordinary athletic experience—even jumping over a fence—you're involved in a scientific process," says Vanderkuur.

Within a year Gerritsen began building rough models and conducting trial runs. The rock face, for example, began as a one-twenty-fourth-scale model, every move on its surface offers at least two handholds and two footholds, each strategically placed for visitors of any size.

Not everything went according to plan, though. For example, Gerritsen wanted an exhibit that dealt with anxiety under competitive pressure. But no one ever found a sensor that could quickly and accurately measure such symptoms as adrenaline flow.

At Sport, rather than passively receive information, visitors learn by doing. In the process, they can also act out their athletic fantasies. "The visitors are the stars here," Gerritsen says. "Participation is more than pushing a button. Everyone comes away with a sense of accomplishment."—Robert Brody

THE WHAT-S-IT QUIZ

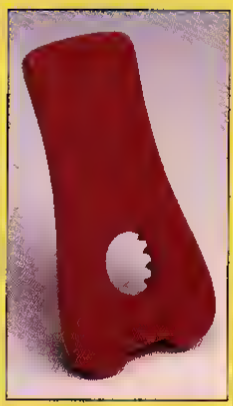
Browsing through gadgets at a favorite kitchen-supplies store, I found an unfamiliar object—a white plastic disc with four holes in it. The holes ranged from about three quarters to one and three quarters of an inch in diameter.

What is it used for? I was puzzled until the clerk explained that it is a "pasta portioner." The amount of spaghetti that fits through the smallest hole is a two-ounce serving. The other holes measure four-, six-, and eight-ounce portions. As long as the pasta is of standard length, it doesn't matter how thick it is. The amount that fits in the hole is a consistent weight.

Pictured above are three plastic gadgets that have specific uses around the house. What are they?

Usually I present these as nonverbal puzzles. I like to hand them to guests and ask, "What do you think they are?" They come up with various theories about how the items might be used, but they're usually way off. After a few wild stabs, they give up. So I tell them. And they smile.

Each of these doodads is, in its own way, a brilliant piece of engineering. Each

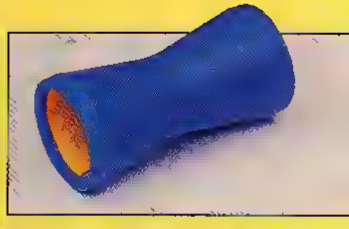


does its job in a simple way. And each has a simple name that immediately tells you all you need to visualize how the thing works. You "get it" just as you might get the punch line of a joke—and you smile.

Read the descriptions below and come up with a possible use for each item, then look at the answers at the end of this page. Prepare to be surprised. You can feel good if you get even one right.

1. A blue square tube, about one and a half inches across and five inches long. It has a hinged yellow piece at one end, shown at the right side of the photograph, and a yellow cap at the other end that snaps shut in place.

2. This red plastic device has a circle about one and a half inches across, that is ribbed on the inside. There's a slot that forms an opening in the top of the gadget, about the size of two sticks of gum.



3. The cylinder is a bit bigger than your thumb, about one inch in diameter. The inside has a rough sandpaper surface that narrows toward the center of the cylinder.

ANSWERS

1. Humane mousetrap. Stick bait to the inside of the plastic cap, and set. A mouse walks in and crawls up the elbow, the tube tips, and the door slams shut, trapping the mouse but not killing it. The owner can then set the mouse free or dispose of it more humanely than the old snap-trap model does.

2. Modern church key. The circular part is used for opening screw-off bottle tops, the slot is for prying up tab tops on cans. This is my favorite gizmo of all—an Eighties reincarnation of the church key, a kitchen tool now almost extinct. The twist-top bottle cap was invented so you wouldn't need the pry-off tool at one end of the church key, and the tab top was invented so you wouldn't need the church key.

3. Cork sharpener. Insert the cork and twist it against the sandpaper until it's narrow enough to slip back into the bottle.

—Scot Morris

FICTION

THE GULAG ON THE RUE DES GRANDES AUGUSTINS

BY GREGG KEIZER

EVERYONE LOVES PARIS IN THE SPRINGTIME. WHAT IF *THIS* PARIS ISN'T QUITE WHAT YOU REMEMBER?

LINOCUTS BY STEPHEN ALCORN

The dead man really wasn't dead and Paris really wasn't Paris. Rannie knew that deep down somewhere.

"Get up." Rannie said to the dead man, but the dead man kept perfectly still. "Come on, come on, get up."

He nudged the body with the side of his boot.

The dead man was his guard. A Slimmer guard masquerading as human in a fitsuit. Rannie wondered if the alien had a name and, if so, whether it was pronounceable. Probably neither, though he had no proof. His dead man had never spoken, not in the six years Rannie had been in this Paris.

Rannie hated Paris, the real Paris. He'd been stuck there in transit once, just passing through on the way back to Malta and the shuttle port. All he'd wanted was to get back into space, to get rid of the nagging gravity, but his papers had gotten shuffled into the wrong files and he had to wait while they were sorted out. Three days in Paris had been enough to make him smash up a small café, cutting up a poor tourist and scaring the waiters into banding together to shove him through the door.

Paris had been depressing. Too many people, too many clouds, too many statues.

Later, safely aboard his ship, he'd wondered why he had hated the city so much. After six years in this Paris, he was pretty sure why. He was alone then, not understanding the foreign words. He was alone now, too.

He turned the corner and walked by the dress shop, then past the entrance to the Hotel Jean Barte. The hotel's door was open, and he could see the dirty floors and dying plants from the street. It had been years since he'd stayed in the Jean Barte. *How do the plants survive?* he wondered. *Who waters them?*

Then he passed by two more glass storefronts, a Russian émigré restaurant and the sidewalk cafe. He kicked a sodden paper cup into the gutter. The rain three nights before had almost washed the streets clean. Shaking his head, he turned at the corner of the Rue Christine and the Rue des Grandes Augustins, walked another block, counting the doorways as he went, until he came to the Wall.

It wasn't a wall, really, just the edge of Paris. He couldn't go beyond it. He'd tried. The patched hole in the street showed where his Slimmer had tilled in his tunnel. Even three meters below street level, cramped in the narrow shaft, the Wall had made him dizzy and sick. He'd fought through the nausea again and again, shoving his head and shoulders against the barrier, but each time he'd passed out. And each time he woke, he was propped against the hotel's door.

If it hadn't been for Margaret's peculiar cell, there wouldn't be anything to show where the invisible Wall began, where his cell finished and hers started. There would have been simply a clear view into the next cell, like the one he had at Kihn's at the other end of his Paris. But Margaret's cell was different. It was a real prison, a camp of some sort, for twelve strands of pointed wire swept across the street on her side of the Wall. Beyond the wire was an open stretch of ground, perhaps five meters, then a single wire set at calf height. More open ground, then two small huts with tar-paper roofs and faded green clapboard. He wasn't able to see the other cell bordering Margaret's; she was on a corner, and her other neighbor was off to the left somewhere.

The wind kicked up small swirls of dust from the camp. He swore softly. Her dirt always blew into this street. That's why he never stayed nights here. Already he wanted to scratch at his dry throat, but when he put his fingers to it he only rubbed softly. It was all he could do to just cough and spit.

Stooping, Rannie picked up an empty tin. The pile of tins was getting small, he thought. *I should bring some with me next time.*

"Margaret!" he shouted, then threw the tin at the near hut. It bounced off the roof and sailed over out of sight. "Margaret!" He reached for another and let it fly, aiming for the farthest hut. They rarely carried that far, but this time the wind caught it, and the metal canister clattered against the side of the building.

He was about to call again when the door of the farthest hut slammed open, and she leaned around its edge and yelled, "Damn you, just shut up, would you? Just shut up!" And she

disappeared inside leaving the door open Rannie grabbed another tin and threw it, but it went only as far as the empty ground beside the hut She would come out again

It took only a few minutes before she was limping toward him, her Slimmer beside her Margaret s guard wore a fitsuit with a face of an old woman—creased lines and liver-spotted—as if that was enough to make them believe she was human, not Slimmer The old woman wore a dark uniform, silvered eagles at the sleeves and Gothic script at the cuffs Margaret's guard never left her just as Rannie's was never alive Rannie had given up long ago trying to understand it all

Margaret was scowling but Rannie knew it wouldn t last She was just pretending She really loved him

'I was writing,' she said when she was near enough Her hair—thin and the color of the yellow dust that blew around her cell—was in her eyes and she pulled it away 'You always interrupt me when I'm working." Her guard stood quietly to one side Like all the other Slimmers they d met she never spoke

'Who'll ever read it anyway?' Rannie asked

Margaret hadn't crossed the thin wire that almost touched her knees She shifted her weight to her good leg and shook her head

"You always say that Rannie You know that you'll read it when I'm done What else is there to do? Her hand idly massaged her left thigh, almost as if she didn t realize that she was doing it The wind blew again and the dust whipped up around her She started coughing hard, her hands up around her throat Her fingers pressed into her skin for a moment before they relaxed and simply caressed her jawline

Rannie looked at her closely trying to see if she d worsened The smudges under her eyes seemed darker the gauntness in her face more pronounced With her thin nose, eyes set just a bit too wide, and teeth that didn't quite meet Margaret had never been attractive

"You look terrible ' Rannie said quietly

Margaret nodded, then did something she d never done before She stepped over the single strand of wire at her knees and came to him Her face was only inches from the twelve lines of sharp wire and with her face contorted in nausea from her closeness to the Wall she whispered quickly and desperately

' I ve stopped eating the food Rannie Haven t you noticed how it smells? And how it tastes? There's something in it, Rannie They re putting something in it Don't eat any of it Pretend you do but don t " Rannie just stared at Margaret for a while his mind locked with surprise

Already the old-woman Slimmer was stepping over the trip wire Margaret stumbled away from the Wall as her Slimmer reached and kept her from falling The old woman dragged Margaret back across the single wire

The shock wore off slowly Rannie opened his mouth, ready with questions when Margaret loudly asked "Dig any tunnels today Rannie?'

' Don t talk like that," Rannie said softly

' She's not a Slimmer " Margaret said Her voice dropped to a low whisper as she glanced at her old-woman guard "Have I told you that before?

"Yes " he said Rannie sighed, decided this was—tainted food and all—just another part of Margaret s paranoia She d believed for a long time that the Slimmers weren t really Slimmers and that this was all just a test somehow of how she should react if the impossible happened and she was taken prisoner

"Dig some more, Rannie Dig us out

Stop it "

' Dig, dig, dig," Margaret began chanting again her voice carrying in the wind

"Margaret this isn t funny," he said leaning too far forward in his quick anger and suddenly feeling faint The street beneath him spun, and then he slowly—*Christ, this is slow,* Rannie thought—fell to the ground

"Rannie Rannie," Margaret s voice was whispering somewhere and for a moment he thought he felt her fingers on his cheek But then he opened his eyes and though her voice was still there her hand wasn t It was only the wind "Are you okay?' she asked and he nodded When he looked up she was sitting too cross-legged in front of the single strand of wire "I'm sorry " she said Really I m sorry I won t do it again "

But she would. Rannie knew She almost always did It was as if she couldn't remember what she d done the day before This seemed so old suddenly like everything was just memories Rannie guessed that they were, that this scene had been played more times than he wanted to count in the three years since the Slimmers had brought Margaret here, her mind messed up, her leg canted too far to one side The leg healed, or almost but that was all

"It's okay" Rannie said finally He looked across the ten meters that separated them and smiled at her The Slimmer standing beside her looked dully back at him Though Rannie knew his cell's and his Slimmer guard's origins well enough—the real Paris and the tourist he'd almost killed in the cafe—he d never had the heart to ask Margaret from what nightmare the Slimmers had pulled her cell s appearance or her guard

' When are you going to come in? Margaret asked "Is the tunnel done?'

No no it's not " He had given up trying to change the subject every time she asked about it she would keep asking until he answered And though her Slimmer listened Rannie knew nothing would come of it The Slimmers had to realize by now that he knew there was no chance of escape It had been almost two years since he d last dug, convinced of its futility Better to just sit and wait wait for the end of the Slimmerwar, and hope hope hope that the Slimmers would win He was sure the only way he d ever see home was if the aliens won their war

It was as if they didn t understand the concept of capture, or surrender or prisoners His ship with three others had caught a lone Slimmer ship half a system from its fleet It had fought until its hull was cracked and its engine pods swept away And even then Rannie's team had to board the ship and hunt the Slimmers down None gave up Rannie was convinced they didn t know how

Which was why when his own ship was breached three months later and he d donned a suit, he had like all his shipmates, put the red tab under his tongue The Slimmers never took prisoners just as they never gave any Some of his shipmates swore they d seen bodies crisscrossed with deep slashes, bones broken in strange places, faces filled with leftover screams No one wanted to be taken by the Slimmers

Wearing fitsuits that made them look like black angels with frost tipped narrow wings the Slimmers had systematically cleaned out each compartment

He and three others had been bricked into the forward weapons-control pod when the Slimmers blew the hatchway and reached in. The other three—Rannie couldn't remember their names now—had swept the tabs from under their tongues and swallowed. In a moment they were dead, their minds empty before their convulsing bodies jerked away in the weightlessness.

But Rannie hadn't swallowed. Instead, with the black angels staring at him, he spit out the tab and saw it smear against his helmet's faceplate. He wanted to live, he discovered, wanted it enough to beat his fear of pain into the background. The Slimmers took him, and for the next five weeks—he counted the days—they kept him in their ship. The aliens would come, one at a time, to stare at him. No two ever looked the same. The ones who wore no covering, fitsuit were the hardest to look at. He still had nightmares about the living skin across their faces, the way it moved on its own. One minute it was bearable, the next it had folded itself into something monstrous.

Eventually they brought him here, to this Paris. The shuttle was a wild ride down. Yet it gently landed in the middle of the Rue Dauphine. He didn't remember any questioning, much less anything as dramatic as torture, and so had no idea how they'd pulled his Paris cell from his mind.

Rannie was sure of one thing, that if the Slimmers lost they would kill their prisoners. Why they had stocked this strange prison with its eight inmates he didn't know. A curiosity, perhaps, or maybe just imitation of what humans did. His only chance lay in the Slimmers winning and releasing their charges out of boredom or lack of purpose. Rannie still thought of escape, thought of it every day, but now he did nothing about it.

"I've got to go," Rannie said, standing up. The Slimmer in black moved aside. Margaret started to pout. "I'm going to go back and dig some more," he lied. She smiled and clumsily got to her feet. She had to pull her leg under her. "I'll be over there soon," Rannie said.

Then Margaret did what she always did just before he walked away from her. She unbuttoned her tunic and dropped it off her shoulders. Her breasts, small, blue veins running across them, seemed to stare at him. Her fingers touched the skin between them. And even though he knew Margaret was sick, not what she'd been before this place, he couldn't help himself. Six years without a woman, and he got hard at the sight. Rannie turned from her in disgust.

Without a farewell, he walked away. Rounded a corner, the one with the bookstore, its rain-splattered windows hiding the displays, and ran into a stranger.

He wasn't Slimmer. Rannie knew, for the man opened his mouth and spoke.

"Name's Graige," he said, sticking his hand out. Rannie didn't clasp it, he was still in shock, so the man withdrew the offered handshake. "What's yours?" His grin was infectious, and Rannie felt himself following suit.

"I don't believe it," was all Rannie could manage to say. "I just don't believe it."

"My name?" Graige asked. "I know it's different, but—"

"No, no, just that you're here," Rannie said. He half-turned, ready to round the corner again and yell to Margaret that there was someone in his cell, when Graige put a hand on his shoulder.

"I listened in," he said. "I hope you don't mind, but I couldn't help it. I just heard voices and followed them here." Rannie was confused, and it must have shown. "It's just that, well..." Graige started, hesitated a moment. "She doesn't sound like she can be trusted. Not sane, is she?"

"Margaret?"

"She might not understand how important this is, see? She might tell—" he said, paused, then continued "—I just don't want her to know I'm here. Not right now."

Graige grinned even more, his hand tight on Rannie's shoulder. The fingers seemed to dig into his flesh. Rannie nodded, but he was the one who didn't understand.

Graige started walking, and Rannie found himself staring at the man's back. He hurried to catch up.

"You been here long?" Graige asked, and Rannie nodded, then choked out a yes when he saw that Graige wasn't looking at him. "How long?" Graige kept walking, his pace quick.

"Six years." Rannie said. "I was on the *Hespatti*. We were orbiting Tingis Home when they took the ship."

"I heard about that," Graige said, and Rannie was surprised. The *Hespatti* had been a small ship, just an eight thousand-tonner. Ishrai's Fleet had been losing ships like it almost every month. But news travels strangely. Perhaps there had been something special about the way the *Hespatti* held off two Slimmer ships, how it had even forced one of them directly into Home's atmosphere.

"I can't believe you're here," Rannie said again, and this time Graige paused long enough to turn. He seemed angry for a minute, but then his grin returned.

"They brought me in an hour ago. I came down on their shuttle this morning." He hesitated. "It is morning, isn't it?" he asked, looking up. There was always a haze in the air, thick enough to hide the sky's true color. Almost thick enough to shade the sun, which was a bit too bright, a bit too far into the blue end of the spectrum. Rannie thought. "Where is this place?"

Rannie shrugged. He didn't know any more than Graige. All he knew was this Paris, his cell. Somehow the Slimmers had seen into his mind, had seen his hatred for this place, and made it real. And it was real. The bricks were worn smooth, and the windows were dirty, just as if this was the real Paris.

They were opposite the sidewalk café now and Graige crossed the street. He edged a chair away from the nearest metal table and clumped down into it. Rannie followed, habit still not letting him cross the street without looking to his left, checking for traffic. He went inside the café, to the back, and picked a bottle from the bar. The Slimmers always replaced what was consumed or broken. Almost always. Rannie glanced at the hole he'd punched in the thin wall beside the mirror. They'd never fixed that.

As he settled into the chair on the sidewalk beside Graige, Rannie saw the dead man half a block away. The dead man was slumped in a doorway on the other side of the street. Rannie looked away, hoping Graige hadn't seen. Suddenly he was embarrassed for the dead man. But Graige had already seen him. "Who's that?" he asked as he pointed the mouth of the liquor bottle toward the dead man.

"Slimmer," Rannie said. "My Slimmer guard. He pretends to be a dead man." Rannie laughed nervously. "I don't know why."

"Slimmer? That's a Slimmer?" Graige was out of his chair now, the bottle still in his hand. "It's in a fitsuit, isn't it?"

"Of course."

HE HAD DONNED A SUIT AND, LIKE HIS MATES, PUT THE TAB UNDER HIS TONGUE. THE SLIMMERS TOOK NO PRISONERS.

"Why haven't you killed it?" Graige asked, and swung the bottle against the edge of the table. The sound carried down the street, and the shards sprinkled the sidewalk, but he still held on to the neck. Rannie shoved himself out of the chair and stood, but Graige was faster. The man was in the street, his boots slapping the pavement as he ran.

Rannie stumbled over Graige's tipped chair, caught himself, and rushed to follow. He wasn't more than four or five steps behind, but before he could reach Graige and yank the man's arm back, the bottle had been jammed into the dead man's chest. The small alcove of the doorway was suddenly too close, and Rannie shoved Graige out of it and against the building's brick wall.

"What are you doing!" Rannie screamed. He pressed his forearm against Graige's throat and leaned his body into it. "He's dead, he's already dead!" Rannie shouted. But as Graige choked and struggled beneath his arm, Rannie stopped. His throat was suddenly dry, and he wanted to claw at the drought inside him.

It was only after he'd managed to hack and spit that Rannie could force himself to look at the dead dead man.

The dead man was bleeding, and the blood was as red as his own. Gently Rannie brushed away the slivers of glass, but he left the bottle's neck alone. He knew if he pulled it out it would only make matters worse.

The dead man had never done him any harm. He'd just been dead, that was all, Rannie thought. The Slimmers had never touched him, not that he remembered anyway, and if he didn't remember, then it hadn't happened, had it?

Now they would *never* let him out, not even when the war was over and the Slimmers told him they'd won. And so he turned on Graige again.

This time he beat his fists into the man's stomach and chest, took him by the hair, and slammed his head against the brick, kicked him when he finally went down to the ground. Graige didn't raise a hand to shield himself from the blows. "Look what you've done," Rannie said, gasping for breath.

He stumbled back to the cafe and got another bottle. Sitting on the curb, he poured the liquor into the back of his throat, finally quenching his thirst.

The dead man was really dead now. Rannie waited for the Slimmers to come for him, or at least come for the dead man's body. But neither happened. Instead he sat on the curb until it was closing on dark. Graige moaned and stirred, so Rannie knew he was alive. But he made no move to help. *I want to go home, that's all. Just go home.*

It was black before he found his way to the Jean Barte. It had been a long time since he'd slept there, but now it felt like the closest thing to home. Just before he stepped inside the hotel, he looked up at the night sky. It was dark, like it was supposed to be, and except for the lack of stars, it could have been any moonless night in Paris.

Rannie breakfasted on a tin of fish, slipping each fingerling slowly into his mouth and swallowing without chewing. Like all the food, it tasted faintly spoiled. He smelled its taint and remembered Margaret's warning, but stuck the thought away and finished. Rannie wiped his hands on his pants and slid the cafe's chair away. He wished he had something, anything, to smoke, but cigarettes were long gone.

He'd searched for Graige but hadn't found him. He was still alive, Rannie knew, because there was only a bit of blood on the walk where Graige had fallen. Not like a few feet away, where the dark streaks ran into the gutter.

And the dead man was gone. Rannie had half expected to see the dead man leaning against a wall or lying in a doorway. He found the absence disconcerting.

He walked the two streets to Margaret's cell, stood in front of Margaret's wire, and shouted for her. At first all he could hear was the rustle of wind on the tar-paper roof of her hut. Then, far away, he thought he heard the sound of someone digging. The noise persisted for a while, then stopped.

"Margaret!" he screamed, afraid. What was she doing? "Margaret, it's Rannie. Margaret, there's something I have to tell you." From beyond the nearest building, he heard voices. It wasn't Margaret talking to herself, although she sometimes did that, but two separate voices arguing.

Rannie wished there was some way to see over the hut, but the Parisian buildings that faced Margaret's cell were windowless. And when he'd tried to pull bricks from their interior walls, all he'd found were more bricks behind the first row, then more behind the second. Then the dizziness of the Wall.

"Rannie!" Margaret shouted, as she limped from around the corner of her hut. There was dirt on her knees and hands, some smeared across her face.

"What are you doing? Who were you talking to?" Rannie asked when she neared the wire.

"Digging," she said.

"A tunnel?"

She smiled and then turned to look back at her hut for a moment before returning her gaze to Rannie. "We're digging right under the wire, right under the tower." She pointed over her shoulder, toward the wooden thing on stilts that he could just barely see off to the left.

"We? Where's your Slimmer, Margaret? The old woman in the uniform. Where is she? Is she helping you?"

Margaret laughed. She wiped the corners of her mouth with her hand and dragged dirt across her face. "Of course not. She's dead." Then Margaret giggled, and Rannie knew she'd finally gone completely mad. "Linden killed her last night. She's lying under the hut there."

Rannie looked, but it was dark under the raised building. "Who's Linden?" He was tired, he realized. Tired because he knew who Linden was even before asking. Tired, too, because he was now sure that he knew who Graige was.

"She came right after you left yesterday, Rannie. She's beautiful, you should see her." Margaret turned, as if she was going to shuffle back to the hut, but then she faced him again. "She said not to tell you she was here," Margaret said quietly, sharing the secret. "She said you couldn't be trusted. You might tell on her."

Margaret touched a finger to her temple. "Linden was afraid that the Wall had done things to your brain, Rannie. Don't you think that's funny?"

"She thought that I'd tell?" Rannie asked. Just what Graige had said of Margaret.

"That's what she said. She killed the old woman with her bare hands. Then she said she knew a way out."

"Out?" Rannie wanted to ask if he could come. Even though Graige and Linden were Slimmers, as it was certain they were, he wouldn't turn down their help. Anything to get out. Margaret looked over her shoulder, as if searching for her new friend.

"She's lying to me, of course. It's all a trick."

"What?"

THE DEAD MAN WAS BLEEDING, AND THE BLOOD WAS AS RED AS HIS OWN. NOW THEY WOULD NEVER LET HIM OUT, HE KNEW.

Margaret glanced again to the huts. "They've put something in the food, I told you that. Now they want me to escape." Conviction marked each word.

"What are you saying?" he asked. Everything was moving too fast, too many changes at once, and now he wasn't sure who was mad: Margaret for not wanting to escape now, or himself for wanting it so badly.

"I stopped eating days ago. I can see what's happening, Rannie. We've got to stay here, the two of us. There's just a small group of Slimmers that want us to leave. I'm sure of it. If we go..."

"What?"

Don't you remember, Rannie? *Don't you remember who you are?*" Margaret's voice climbed, and a woman's face appeared at the corner of the nearest hut. She was whole and untouched and beautiful, just as Margaret had said. "I know who I am, Rannie, why don't you? I've remembered..."

"Margaret!" the beautiful Linden called. She half walked, half ran to the wire, eyeing Rannie. He looked away. "We've got work to do, Margaret," she said, and her voice was smooth where Margaret's was ragged. She smiled at Rannie, and for that moment she could have been Graige's sister. They smiled the same. She started to lead Margaret away, her arm loosely draped around the woman's shoulder, though Rannie could see the fear in Margaret's face.

"I'm going home, Rannie," Margaret said, much too loudly. "I'm taking my story and I'm going home."

"I love you," he said, not sure if it was a lie. He noticed red marks on Margaret's neck. As he watched, she coughed gently, then raked her fingers across her throat. Rannie put his fingertips on his own throat and tried to make them scratch against the rasp deep inside him.

She laughed, hard and rough. "I'll put you in my story, Rannie. They'll read about you back home and cry for you." And she turned and hobbled across the clearing, vanishing behind the hut, the other woman's arm showing for just a moment as it curled even tighter around Margaret's shoulder. The sound of digging resumed, and no matter how loudly Rannie shouted her name, Margaret did not reappear.

He edged toward the Wall. But as he leaned forward, wanting to feel the sharp wire on his fingertips, the dizziness and the nausea returned. He had to know what Margaret knew, what she remembered. So he drew back, bending at the knees, and launched himself at the Wall. That one moment, as he was off the ground, his body laid out flat in the air, he thought he heard laughter in the background, and tasted hot metal in his mouth.

"Wake up." Rannie heard the voice dimly say. He felt someone shaking him. "Wake up, we've got to get out of here."

In his dream, Rannie thought he was listening to himself talking to the dead man. Then he remembered that the dead man was truly dead now.

Graige looked down at him. A bruise across one cheek was all Rannie could see to remind him that he'd tried to kill the man. No, the Slimmer. That was what Graige was. Rannie sat up, propped against the bricks at his back. He was sitting in the doorway of the Jean Barte.

"How are you feeling?" Graige asked, concern in his words. *Doesn't he remember me beating his head against a wall?* Rannie tried to pull away from the thing that pretended to be a man, but there was nowhere to go. "Can you walk?" Graige asked, grabbing Rannie's arm and pulling him to his feet.

"Go away," Rannie whispered. The hairs on his arms stirred, and he felt clammy where the Slimmer had touched him. Graige only shook his head and smiled.

"I came to get you out, Rannie," Graige chided. "*We* came to get you out."

"You're not real," Rannie said. "You're a Slimmer. I know you are." Not for the first time, Rannie wondered if he hadn't really died six years ago, had swallowed the poison capsule, and that this was only his private hell. But he felt the bricks against his back when he leaned on them; he smelled the dust right inside the Jean Barte's lobby.

Graige blinked and then slowly shook his head. "You've been here too long," he said. "I'm as human as you are." He grabbed skin, a tight pinch just above his wrist, and pulled hard. "See no fitsuit. And I talk. Rannie. Do the Slimmers ever do that?"

Rannie felt the dryness in his throat again. Margaret's words filled his thoughts. *'Don't you remember?'* she had asked him. He tried, he really tried.

"I killed that Slimmer for you, Rannie. That dead man."

He wanted to believe that Graige had come to help him escape, as had Margaret's Linden, but then her warning returned—that it was all a trick. He believed in the Slimmer cruelty, in its purposelessness. Yet in the same thought Rannie deeply believed in escape.

He couldn't have both, he knew, so after long minutes he decided. "Home?" Rannie asked. He tried to stop it, but for the first time in six years he felt the hope so strong he could see home in his mind's eye.

"Away from this," Graige said to him. "Home with me, and all the rest."

"Away?" Rannie felt weak, as if nothing he did, or could do, was going to make a difference.

"Let's go," Graige said, tugging on Rannie's arm. Rannie followed as they stepped inside the Jean Barte's lobby. Their feet left tracks through the dust, and Rannie coughed as they climbed up two flights of narrow stairs and walked down the third-floor corridors. The smells were of old women and rotting fabric, and Rannie had to breathe through his mouth.

Look." Graige said finally, and pointed where a window should be. Instead the glass had been broken out and the frame splintered. Rannie tried to remember what the window had shown before, but nothing came. If it was like any other, it should have been only brick through the glass. But the bricks were gone, and as Rannie peered through the opening, he realized he was seeing outside his cell. The passageway was narrow and rough, but large enough to squeeze through.

Framed by the tunnel, the light bright in the dim corridor, was a small coppice of scraggly trees, or something that looked like trees. They were red and stood in the midst of thin grasses that reached as far as he could see. There was no one waiting for him. No Slimmers with shifting faces ready to kill him if he stepped out. A breath of wind carried into the hallway from outside, stirring the dust. Rannie coughed.

"I lied to you before," Graige said. "I didn't come here on a Slimmer shuttle. We came in our own ship. We finally found you, and now you're going home with us." Graige was peering through the shattered window as he talked to Rannie.

"And the war?"

Graige turned and faced him. "It's almost ours. We've won. By all rights we've beaten them, but they don't know it. They don't understand how to stop." Rannie nodded, recalling the Slimmer ship and the unrestrained fury of the Slimmers. "We can't persuade them that the war is over, that we'll quit if they will. We can't get our hands on one. They never surrender."

Then Graige ducked into the passageway, his shoulders rubbing mortar from the bricks and showering Rannie in the dust. He held his breath and closed his eyes, but still he coughed. The light was blocked for a moment, and the hotel corridor was black. When the light returned, Rannie could see Graige standing outside the walls, knee-deep in the grass. "Come on. There's not much time." When Rannie didn't move, Graige shouted, "I had to kill your dead man! He wouldn't have let you leave here alive; we had to kill your guards to get you out, Rannie!" His voice pleaded.

In the background, far beyond the red trees, Rannie watched as a shuttle thundered to the ground. It wasn't a Slimmer ship but a simple craft all Earth vessels carried. The *Hespatti* had had one just like it. And when the hatch slid open, he saw figures step onto the grass. Human figures.

Rannie could only stare as the first figure waved a hand. "Rannie!" shouted Graige. "There's more like the dead man. We have to run. Now!" As if to lead by example, Graige ran through the grass toward the shuttle and the men.

Home, Rannie thought, his eyes still locked on the shuttle and the men beside it. Men. He savored the word, saying it several times. Stepping into the tunnel, his shoulders catching for a moment on the brick, he squirmed toward the light, Graige, and the waiting ship.

A shadow passed across the light, and from the corner of his eye Rannie thought the shape was an outline of wings, wings just like the Slimmer black angels had had when they'd come aboard his ship.

"Rannie?" A woman's voice reached for him through the passageway. It was Margaret's voice. He crawled forward in the dark until his hands wrapped around the mouth of the tunnel. "Rannie, don't come out. Stay in there, Rannie." There was panic in her voice.

Margaret stood in the daylight, one hand clutched around her throat. Her eyes were opened wide, and she trembled gently. She stared into the tunnel and said, "I was right." Rannie looked for Graige, who was still running toward the ship.

"Rannie, listen to me." Margaret said quietly, and he squinted at her. He squatted in the passageway. She limped forward until her face blocked out the sunlight. Even in her shadow he could see the blood at her throat. "Don't come out. It's just a lie. They lied to us. I knew that, but I had to trick them. I had to kill Linden. I'm sorry," she said softly, and put her hand on his. She left blood there, slick and hot, and he imagined Linden's face in the blood-ied patterns on his palm.

"We're going home," he whispered. He pointed to the shuttle and the figures in the distance. "Look, Margaret. They've come for us. He said the war was almost over, that we've almost won."

They want to take us to their world." She pointed to the shuttle and its crew. Graige was almost there now, and he had just begun to turn around to find Rannie.

Rannie looked back down the tunnel he crouched in, saw the carpet in the hallway, and smelled the faint stench of mold. Paris. He was going home, to Paris. For a minute he couldn't decide if he was there already or had yet to leave. His head hurt, and he pressed his hands against his eyes to ease the pain. When he looked up, Margaret was still there, the shuttle ship behind her. Graige was waving his arms and yelling something, but he was too far away to understand.

Rannie simply said, "Home," and pulled himself from the Hotel Jean Barte and stepped onto the alien grass.

Margaret had a bloody hand on his face now, and her fingers slid down until they were at his throat. "We can't go! They'll make us give up! Remember, Rannie, can't you remember?" Her fingers scrabbled at his throat, and he had to grab her arms and forcibly push her away. Graige was nearing them now, and two of the shuttle crew were close behind him. Rannie heard him say, "No!" in a half scream.

"Don't you know, Rannie? Don't you know who I am?" Margaret pulled at her shirt. "Don't you remember what I am?" She stepped back into the light, her shirt off her shoulders. She let it drop onto the grass. Rannie stared at her nakedness for a moment before closing his eyes.

"Margaret, please don't," he said. But when he opened his eyes again, she had worked her pants down around her knees. He felt that same slight sickness deep inside him as he looked at her twisted body.

"Try to remember who I am," Margaret whispered. "I remembered when I tricked them. I only pretended to eat their food. Try, Rannie." He shook his head. Margaret smiled, then put her hands just below her chin. Gripping the skin hard enough to whiten it, she pulled quickly. With a sound of ripping cloth, she came apart, the skin sloughing off like old bark falling from a tree.

The fitsuit slipped from her body until there was only her face. The rest of her was gray and scaled with tiny horizontal scars. Where her breasts had been there was only a flat expanse of stripes. "Margaret" was all Rannie could say before she grabbed at the skin now loose on her throat. She pulled again, and the mask shredded in her hands. Wide green eyes stared at him, and her face moved as he watched. It crawled, a life all its own, and formed itself into impossible patterns and shapes. But the words that came from her thick slash of a mouth were still human. "We're just a small group, Rannie, trying to find an end to the war that must end. We let them turn us into something we're not. Feel human, feel what it's like to give up. *We're* the Slimmers, Rannie.

"If we go with the humans, they win. They need a Slimmer to talk to, to negotiate with. A Slimmer who thinks he's human. Who will stay alive long enough for humans to take him away."

Her words took him back to the weapons-control pod and the black angels who had swept through the blown hatchway. For that moment, he knew the memory was not really his, that it had been stolen, and that if he looked in the mirrored faceplates of the angels he would see a face like Margaret's. The moment passed, and all that remained was his horror. Margaret was a Slimmer. Graige was a Slimmer, the dead man too. There was no one to trust, no one to aid and comfort him. He was truly alone. Not even the shuttle, calling him home, was enough now.

"No," he hissed, retreating from the passageway and escape. "No!" and this time it echoed in the narrow corridor.

As he backed away, he saw Graige approach, then knock down the thing that had once been Margaret. She struggled in Graige's arms, the last remnants of her fitsuit falling to the ground.

There was something shiny in her hands, and she struck at Graige with it. He screamed and clutched his face, blood running between his fingers. She shoved him away and turned to the tunnel and Rannie. The knife in her hand was homemade, a piece of metal sharpened on one edge.

"Don't let them talk you," she hissed. Her Slimmer face flowed like melted plastic over fractured concrete. "I'm right about it all. I know I am. We've turned ourselves into something else. We've done too good a job of it, Rannie."

She raised the rude knife. "What are you now, Rannie? Slimmer or human? I know what I am. I remembered in time." Margaret buried the knife in her throat, and Rannie shut his eyes as the blood flew at him.

When he had the courage to open his eyes, Graige's wounded face filled the end of the tunnel. Graige yelled at the two crewmen who stood awkwardly behind him. "She's dead! Get him out of here!" Behind him Rannie saw two, then three, then four people dash through the grass to the waiting shuttle. Graige said something to one of the crewmen, who spoke into a small nugget between two fingers. The shuttle's engines coughed, then roared, and dust flew from beneath the machine.

"Come on! Take him aboard. He's the only one now." Graige turned, bent down, then rose into view again with Margaret's shed fitsuit in his hands. Four arms reached into the tunnel. Rannie was crouching in, blocking out the light. He tried to move back, return to the Hotel Jean Barte and his Paris, but the hands grabbed him and tugged. Rannie put his hands in front of his face and screamed. The dust from the shuttle blew into the darkness and tore at his throat. He put his hand there, ignored Graige's shouts, and ripped at his neck for the dust inside him. Before he blacked out he felt thick folds of skin part beneath his fingernails and felt rough, scar-crossed flesh deep inside.

Rannie woke with hard metal beneath him. The quiet sigh of a ventilator told him he was on a ship. When he opened his eyes, he glanced around the small cubicle. He stretched until his hands and feet grazed the ends of the bare cell.

That was what it was. He was on the humans' ship, he knew, and more a prisoner here than he'd ever been in Paris.

Rannie—he thought of himself as Rannie, even though when he looked at his reflection in the burnished metal wall he knew his Rannie memories were had been all along, simply illusion—didn't bother to call for help. In Paris, at least he'd had Margaret for company. There would be nothing like that here.

His face, his Slimmer face, stared back at him from the wall. It moved as he watched with strangely lit eyes. He knew it was his, for when he moved his hands—he still thought of them as hands—they touched the face in the image.

Margaret had been right. The food had been poisoned. Now, with its effects shocked from him and his fitsuit torn from him, he knew what he was. Slimmer. Even worse, captive. He searched his mouth for the capsule, remembering the memory of Rannie's capsule and understanding *that* had been real, that Slimmers always carried them, but there was nothing there. He wanted to kill himself, part of him did anyway, to take the shame away. But when he looked at the wall again and had to turn from it in disgust, he knew that something just as strong inhabited his soul.

Humanity. There was a human inside him now. Even the name that he thought of as his was human, not Slimmer. And because of what was there, that humanness his own kind had put there with drugs and prison, he felt just what every other human felt for the Slimmers. Hatred.

Slimmers had given him to the humans. But to keep him from remembering what he was, to fool him into believing he was human, not Slimmer, they had made him human. And humans hated Slimmers.

They had managed to trick him long enough to keep him from doing what Margaret had managed to do, but the price had been so high. "Hate myself," he whispered, looking again at his reflection in the metal wall.

A part of the metal cleared, and Graige's stitched face appeared. He was human, not Slimmer. "You're safe," he said. "When you're ready we can talk." Graige paused. "Your people promised there'd be two of you among the real prisoners ..." he said, sounding disappointed that Margaret was not there, too. "They said you wouldn't remember who you were. I'm sorry it came out like this," the man said. He waited for a reply, but when none came from Rannie, the face was replaced by metal.

The humans wanted someone to talk to. Someone who would listen to their terms and help them find a way for the Slimmers to give up. Someone to negotiate with, then someone to take the surrender terms home. And finally, someone who could make the Slimmers understand what it meant to give in, but not die.

And the Slimmers, what did they want? Rannie remembered the conspiracies, the plans they'd had, Margaret and himself offering to bring the plan to life and light, give in to the humans, go to their world, talk to them, come home again.

With proof—themselves—that it was possible to surrender and remain alive. Even more: alive and sane and sane. With proof like that, they reasoned in their secretive times, all Slimmers, even the most powerful ones, would see that there could be an end to the war that they were losing so desperately.

Things had gone so well, Rannie thought. The dead man, Margaret's guard, everything of his Paris had worked so well. Too well, for he was only part Slimmer now, more than part human. He was too human, for he hated the Slimmers so much that he would help the humans find *their* end to the war.

Rannie turned away from the metal wall and closed his eyes, trying to forget that his face moved when he wished it still. Paris came to the inside of his eyes: the Paris of Rannie's dreams. The real Paris, more than the Rue des Grandes Augustins.

He would carry the terms back to his own people, the Slimmers. But no matter what the humans told him was acceptable, the terms would be his, not theirs.

There will be no surrender, he read from his imagination. *We will destroy your worlds, erase you from the universe. Kill yourselves, or we will kill you.* Those will be the terms he relates. *Hate the Slimmers,* he said softly from his human half. *Hate them enough for genocide.*

And yet love the Slimmers, he said softly from his Slimmer half. *Love them enough to let them end it as it should be ended.*

"Don't let them take you," Margaret had said. They had, but Rannie would find an end as right as hers. The end both halves within him demanded. He made himself look at the reflection in the wall again, and the Slimmer face there shifted into what Rannie could only assume was a smile. ∞

CONTINUED FROM PAGE 68

give medicine nearly complete control over the structure of living matter. It will be possible to build organs from scratch, molecule by molecule, to splice nerves together, and even to cure such conditions as severe frostbite. In the future medicine will probably consider patients to be alive and in potentially perfect health so long as their brains are intact. I expect that physicians will view patients who are frozen today as being in potentially perfect health—and treat them accordingly.

Omni: How about outfits in California that have frozen people in hopes of eventually reviving them? Are they really dead?

Drexler: If the medicine of the future can restore people to health despite severe long-term frostbite, then so long as their brains are intact, cryonic freezing isn't necessarily fatal. Their being revived wouldn't violate any known law of nature.

Omni: How about rejuvenating people?

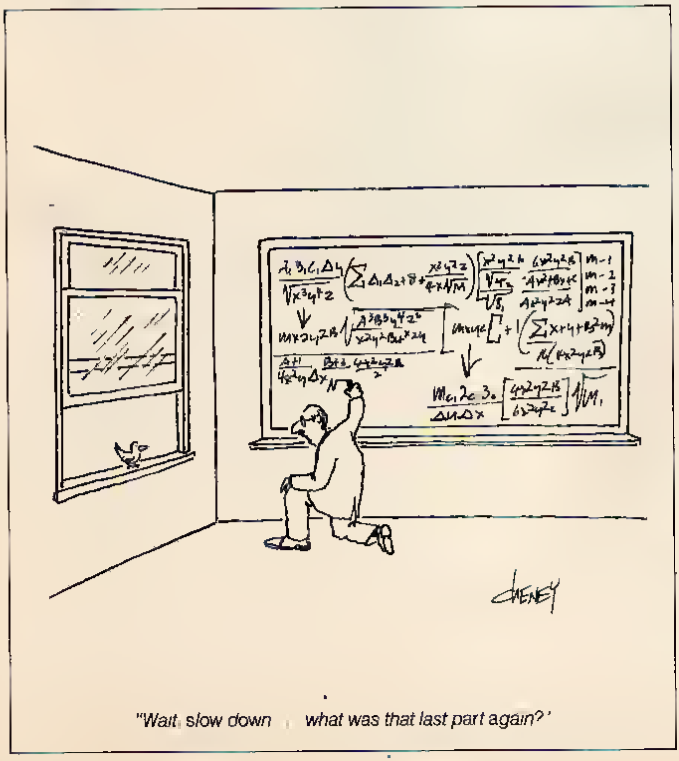
Drexler: The aging process consists of changes in the molecular and cellular organization of living tissue. Nanotechnology will give us something approaching complete control over the structure of living matter. That should be enough to reverse those changes and therefore rejuvenate people.

The limits to human longevity would then be set by accidents and environment, rather than by internal biological mechanisms. The major causes of death in modern societies have to do with peoples' physical conditions deteriorating. That involves their molecules no longer being organized properly. Repairing things on the molecular level should enable you to maintain youthful health.

The only diseases to remain incurable despite this tremendous repair ability would be those involving the irreversible loss of vital information, diseases that destroy the information patterns in various portions of the brain. But I suspect that with rapid treatment even a crushing head injury—unless it were a *splattering* head injury—might well be something that could be dealt with.

Nanotechnology will let us have greater material abundance with less environmental impact. We'll have things that are lighter, more efficient, and that are produced without pollution as a side effect. So it should be possible to have more people and wealthier people and yet be less crowded and less polluted. But because population growth is already exponential, in the long run we'll have a population problem—either with or without nanotechnology.

Omni: What's the difference between nanotechnology and various efforts at miniaturization involving microscopic gears and other microcomponents?



"Wait, slow down . . . what was that last part again?"

Drexler: Real nanotechnology is intrinsically a bottom-up process. You have to do it by arranging atoms. You can't get complete control of the structure of matter by starting with a large lump of material and whittling away at the surface. That's the style of conventional microtechnology. There are conceivable roles for microtechnology in helping us to build a first generation of nanomachines. But those technologies aren't crucial to the development of nanotechnology.

Omni: How did the idea for nanotechnology first pop into your mind?

Drexler: It developed as a series of images of molecular machines. The key realization was that you could build something like an industrial robot arm out of molecular parts and have it build further things out of other molecular parts. That's the idea of the assembler—a molecular machine that's able to use molecular tools to build other molecular machines. The molecular tools will be reactive molecules that can be manipulated. A reactive molecule is one which, when brought up next to other molecules, will undergo chemical change and form chemical bonds. Some molecules like nitrogen are relatively inert. Others, like acetylene, are relatively reactive. This includes fragments of molecules, which are very eager to form bonds with other molecules.

Omni: What might a typical assembler look like?

Drexler: Something like an ordinary industrial robot arm but vastly smaller, much smaller than a bacterium, smaller even than a human cell's nucleus. So small that the surface is knobby because it consists of a countable number of atoms.

Omni: A bumpy robot, sort of like the Michelin man?

Drexler: Something like that. They'll be devices made of many more elementary devices including moving parts, bearings, gears, motors, drive shafts—essentially the full range of components we're familiar with on a larger scale. And a crucial component of complex systems of this sort would be nanocomputers programmed to control this complex activity.

Omni: Have you designed a complete assembler yet, down to the smallest working part?

Drexler: I have a design in some detail for an advanced robotlike assembler. I don't yet have a nice drawing of it. I need to get a better number for the stiffness of certain bearings in it so that I know how wide to draw certain parts. A device like this can be about one hundred nanometers long by thirty nanometers in diameter. That's roughly a thirtieth the diameter of a bacterium.

Omni: How about a visual description of this robot arm and a few of its parts?

Drexler: A probable structure is a jointed, tapered cylinder made of carbon atoms with regular crystalline arrangements like those in a diamond to make the walls strong and stiff. The arm would swing

through a certain arc, reach out, reach back, have a wrist that could pivot, and at the end a gripping apparatus for tools. Industrial robots usually have a simple attachment point, and the tools attached there are often large and complicated. It's as if they have interchangeable hands. The nanorobot might have a simple clamp, and the tool might have a fair amount of complexity associated with it.

Omni: What would a typical workday for an assembler be like?

Drexler: There would be one cycle after another of having a tool—where the tool is [electrically] charged with an active molecular group—handed to it. It would take the tool, move forward, and apply that tool to the surface of a workpiece, bonding some atoms onto it. Then it would pull back, have the old tool swapped out, and a new one swapped in. It would do this perhaps a million times a second.

Omni: What an assembly line!

Drexler: If you're turning out a lot of one kind of product, it certainly makes sense to have an assembly line where the parts move by one workstation after another. In this case, the assembler arms can be very simple things that maybe move in one dimension and look like a stamping machine—a stapler, or something else that's good for only one repetitive task. General-purpose assembler arms are the core technology because that's what you'd use to build more specialized assembler arms.

Omni: It's hard to conceive of them being in a room. What's the immediate environment going to consist of?

Drexler: Typically they'll operate in vats of liquid rich in the raw materials and fuel the assemblers will need to do their construction work. They'll be controlled by computers programmed presumably in some ordinary language used to control regular industrial robots.

Omni: What's the interface between us and these tiny machines?

Drexler: You could have one nanocomputer interface with the assembler, or you could transmit instructions directly. You'd load information into nanocomputers—initially through electrical wires large enough at your end to get hold of with conventional microtechnology. These would taper to fine wires at the other end where they'd connect with the device.

Now most of what I've done is to describe how an established nanotechnology might work. A separate question is the process of actually developing that technology. That is, starting with today's tools and techniques, how can we build devices that build devices that build devices like the ones I'm talking about?

Omni: The more you describe it, the longer it sounds like it will take. Are people who claim nanotechnology will be operating in thirty years being realistic?

Drexler: It's hard to guess how long it will take. That's different from the question of what's possible, which involves natural law and calculation. The first is a question of human activities and cleverness, of how soon and vigorously people apply themselves to various problems.

Omni: Were you the first person—other than the late Nobel prize-winning physicist Richard Feynman—to have the idea of a molecular assembler?

Drexler: I don't know anyone before me who described building robotic systems out of molecular machines. The closest anticipation was Feynman in his 1959 article "There's Plenty of Room at the Bottom." Here he indicated there was no reason you couldn't move things atom by atom and that you might somehow use this ability to synthesize chemical substances. I first read his article while I was preparing the references for my 1981 *Proceedings* paper. It was amazing that someone pointed in that direction in 1959. But no one had fleshed out his ideas to explain how you could build nanomachines that do chemical synthesis.

Omni: Earlier you spoke of electrical wires being the interface between people and assemblers. Wouldn't broadcasting instructions by radio be more practical?

Drexler: Light would be a good source for power. Or you could control nanomachines by illuminating them with different colors of light. Turning different light beams on and off would produce photochemical effects. We know that light can not only affect molecules but can even activate mechanical changes in the shape of molecules. This is how we see—by a molecule that goes *chonk* into a different shape when exposed to light. And molecular motions like these are usually measured in trillionths of a second.

Omni: Won't quantum indeterminacy, that imprecise behavior of subatomic particles, at least limit our ability to work with atoms on a one-by-one basis?

Drexler: Quantum indeterminacy limits some things that you could do with molecules. But for practical engineering purposes at ordinary temperatures, it turns out that thermal vibrations [the ordinary random motion of molecules and atoms] lead to a greater possible problem.

These molecular motions can't just damp down and stop. There's a certain amount of kinetic energy in an atom's motion, which by conservation of energy can't just vanish. The best place for that energy to be is largely in the form of random vibration of molecules. By vibration I mean that the whole atom, or molecule, is rattling back and forth, bumping up against its neighbors.

Omni: Isn't it going to be hard for the robot arm to catch and manipulate these vibrating things?

Drexler: Yes. Thermal vibration poses one of the most important problems in designing molecular machines. You can take advantage of it, though, by letting the random thermal motion bring the molecules to you and then using selective stickiness to hold onto the molecules you

want. That's how enzymes attach to the molecules they work with. But for an assembler arm positioning a molecular tool in a precise place, it's very important that thermal vibration not make the arm bump to one side and botch up the job. The way to avoid that is to make the arm stiff enough so that the vibrations can't move it very far. That's the reason I designed the robot arm thirty nanometers in diameter and a hundred long. These dimensions make it a fat and stubby thing—they make it stiff enough. Of course, because vibration occurs on all scales, the whole arm is jittering a little bit. But if it's stiff enough the arm is seldom going to be out of place by more than half an atomic diameter.

Omni: If your own arm were an assembler robotic arm, how large would an atom it was trying to manipulate be?

Drexler: The size of a BB shot.

Omni: Okay, how does the arm actually grab the atom it wants?

Drexler: The initial contact would be by something sitting there waiting for the right molecule to bump into its grip—through selective stickiness. The best model of this is the way active enzymatic sites work. They have a cavity whose size and shape just perfectly fit the molecule in question—and no other molecule. So when the right kind finds its way in, it tends to stay there for a while. "Ah, we've got one," you say, and pull that molecule in. The rate at which enzymes process molecules is about a million times a second for a fast enzyme, if there's a high concentration of the molecule around.

Omni: Why are you convinced this is going to work?

Drexler: I've presented these ideas to audiences full of chemists, physicists, and engineers, and I've yet to find someone who can give me a reason it won't work. And based on what we already see in chemistry, biology, and physics, these things *do* work. Proof for self-replicating systems of molecular machinery exists in the form of bacteria. Anytime someone makes yogurt, he's demonstrating that self-replicating molecular machines work.

I can't see how to construct an argument against these ideas that does not also deny things we know exist. On the other hand, I find it hard to believe that automobile engines work—all those moving parts grinding against one another with things exploding inside them. They're made of materials known to combine with atmospheric oxygen and turn into a crumbly reddish material!

Omni: How can we tell whether these assemblers and nanocomputers are doing their work properly?

Drexler: We'll develop instruments for sensing molecules and finding out what's going on. We already have that with the scanning tunneling microscope, which draws pictures of reasonably smooth conductive surfaces, and with the atomic-force microscope, which forms a picture of a molecular surface by doing something like running a tiny finger over it and feeling where the bumps are. It has a sharp point that's pulled across a surface, much like a record stylus.

Omni: Nevertheless, we really don't have any proof that something this fabulously complex will work—or even be possible.

Drexler: We do have the observed fact in nature that at one point the world had nothing more complex in it than bacteria, and now it has human minds. There's no good argument for believing the limit of complexity has been reached.

Omni: Turning to practical applications, would nanomachines cure, say, cancer by finding the malignant growth and killing it at the molecular level?

Drexler: Once you conceive of nanomachines as something like white blood cells with the ability to move around, to sense structures in a molecular way, and to do something about it, it's obvious that one of the simpler medical applications will be the selective destruction of cancer cells, AIDS viruses, cold viruses, and so forth.

Omni: Will human nature change with all this material wealth?

Drexler: My working assumption is that human nature doesn't change but that people do different things in different environments. If we make it easier for someone to have a car that drives itself, then there'll be less excuse for drunk driving and you will see less of it. And if a woman can wear a necklace which, when shaken, calls the police and broadcasts a live video of what is going on around her, then the numbers of certain forms of crime would presumably drop.

Nanotechnology will change the lives of everyone who takes advantage of it. By making extremely high-powered computers cheap, lightweight, and portable, nanotechnology will let everyone, including children, have access to virtually all the world's knowledge in a paperback-book format that they can carry around in their pockets. And if a child wanted to see a little elephant, he could quickly get an animated three-dimensional model or a lifelike miniature robot elephant. And by giving kids control of assemblers and a pinch of raw materials, they'd have the equivalent of a Tinkertoy set with more parts than they could possibly count in a lifetime.

Omni: Might a child destroy the world with his or her assembler?

Drexler: I thought of this Tinkertoy set in the context of sealed assembler labs. The sealed assembler lab would be something about the size of your thumb, with the actual lab part being about the size of a small speck of dust. If the lab contains a very small pinch of raw materials and the only thing that comes out of it is information, it won't be very dangerous.

Omni: What if nanotechnology falls into the wrong hands?

Drexler Then we're in a lot of trouble. Besides all the positive things we've talked about, this technology will greatly expand people's ability to build better or more powerful weapons and systems for monitoring what people are doing. In the wrong hands this technology could be used to gain power, perhaps absolute power, or destroy entire populations or ecosystems. To avoid these sorts of abusive nanotechnology, it's vital that the technology be developed by the most responsible organizations and that these organizations build defenses against potential abuses.

Omni How can anyone control who develops and uses nanotechnology first?

Drexler People in all the major industrialized countries are going to compete to develop it first [probably in large-scale, government-sponsored projects] at some point. Therefore the only way to guide its application is to be part of the community of people that controls it. I hope there will not be a first *country* to develop nanotechnology but that a family of democratic nations will jointly develop it.

Omni Even if democracies do develop it first, how can they keep the secrets away from other countries?

Drexler We'll have better answers to those questions when we're closer to developing the technology. We in the democracies probably cannot produce a major strategic breakthrough in perfect secrecy. Too many people would be involved for too many years. I described a long-term solution to these problems in *Engines of Creation*. It involves the construction of active shields. The basic notion of active shields is that defense against molecular machines will involve other molecular machines. Our immune systems defend us against bacteria and viruses. We should be able to build a nanotechnology-based immune system, protecting against analogous problems. To deal with microscopic threats, one wants to use microscopic defenses—yes.

Omni So sealed labs would be important here.

Drexler One concern about nanotechnology is, How can one let people experiment with it freely but not risk having an experimenter do something dangerous with it before you have defenses in place? In the sealed labs, one could experiment with assemblers, replicators, and the construction of various gadgets—inside the box. One could get full data on how they would perform but without the experimenter being able to get the actual hardware out of the box.

Omni What's the so-called gray-goo problem all about?

Drexler It involves the vision of a replicator, an assembler-based system designed to be able to eat a wide variety of materials and convert them into copies of itself. The gray-goo problem would arise if someone deliberately designed an omnivorous and uncontrolled replicator. Such a device could destroy the biosphere. So it's important that before irresponsible parties do such a thing, we have some kind of protective measures in place. It's important to understand that that kind of replicator is not going to happen by accident. For an industrial replicator designed to operate in a vat of special chemicals to "accidentally" turn into a replicator that's able to survive in nature would be about as likely as a car—just by an "accident" in a garage—being able to wean itself from its diet of gasoline and transmission fluid and go out and live on tree sap in the wild!

Omni Do you ever have nightmares about how all this could go wrong?

Drexler Between the time I thought of the idea in 1977 and when I began preparing my paper in 1980, I said almost nothing about it because I was afraid of the consequences of accidents or abuse. Later I learned that abuse is the real issue and accidents are easily avoided. I published my paper because technology was moving in this direction anyway, and I thought it was important that people understand it before it got here.

My greatest fear is that we'll see a polarization between two groups: those who are blind advocates of the development of nanotechnology, and those who blindly oppose it. I hope we'll see a constructive dialogue between those groups, leading to the formation of sound policies for guiding its development.

Omni Would nanotechnology help people go back to the land and farm their own one-acre plot?

Drexler Yes. Nanotechnology is far more compatible with going back to the land than is, say, the technology of metal and petroleum-powered machines. Stone Age people used self-replicating molecular machines packaged in the form of animals and plants. Obviously they didn't need an industrial civilization to make their plants and animals work. Likewise, people living close to the land, aided by nanotechnology, will not need a huge industrial civilization to keep their molecular tools working.

Omni I've heard that you've referred to yourself as a "nanarchist." What kind of political orientation is that?

Drexler Oh, that's just a play on words. I'd like to see a future in which people have the freedom to pursue a wide range of ways of life and not get in one another's way more than they want to.

Omni What ideas do you have right now that you haven't presented before?

Drexler Um, well, okay. It seems plausible to do chemical transformations of molecules by putting them through something that looks like a mechanical grinder! You might be able to put in water and grind out hydrogen and oxygen using mechanical power to drive the process. And more speculatively, you might be able to take hydrogen and oxygen, put them in the output end, run the whole

thing backward, and get mechanical power—with great efficiency. But this is something I *don't* have confidence in, unlike the other ideas I've discussed.

And here's an off-the-wall idea, something where the calculations that say either you can or can't do it haven't been worked out yet. First, nanotechnology will make it possible to build enormous reflecting telescopes using thin film materials in deep space. I mean telescopes on the scale of planets and solar systems. If you look in just one direction, you can make a telescope that'll work just fine. Then these telescopes might peer at light bent by a black hole. So you might see what our solar system looked like hundreds or thousands of years ago, using the black hole, in effect, as a mirror.

Omni: Could you zero in and see, for example, Columbus crossing the Atlantic?

Drexler: It depends on the size of the black hole, unfortunately. The resolution you can get on objects is proportional to the size of your mirror—the larger the better. In this case it would be the diameter of the zone in which light is turned one hundred and eighty degrees by the black hole. That's not much larger than the diameter of a black hole. And stellar black holes are not all that large. The really large ones tend to be in the middle of a thick mass of matter in the center of galaxies, which may be too opaque to do the trick with them.

It's pretty clear that you can do this trick at least for nonrotating black holes with everything lined up right, but the question is, How much light are you capturing and how much resolution do you have? In principle, you could recover light emitted in the past and therefore see into the past. But it may be that your view is very dim and blurry, so that you can't see any kind of human-interest stuff.

Omni: You used to be heavily involved in the space-settlement movement. Why have you changed your focus?

Drexler: At present my suspicion is that we will have assemblers and nanotechnology before we have large-scale space development using more conventional technologies. With replicator-based production, we'll get superior materials for spacecraft and so forth, all at trivial costs. As a result, large-scale opening up of the space frontier will be easier.

Omni: So you think we should develop nanotechnology before we go into space?

Drexler: It's not that I think that's the way it *should* be. I think that it's the way it probably will be. Not too long after we learn to apply nanotechnology to produce a space system, we'll build domed museums over whatever small, struggling installations we've previously built on the moon or Mars. These will be declared branches of the Smithsonian Museum, and theme parks will be built next to them. Regular tourist traffic will begin, with the tickets being extraordinarily cheap. And we'll go on from there. ∞

ARK DE TRIOMPHE

CONTINUED FROM PAGE 56

lected data on age, sex, death rate, range and social interaction among animals. They grew to know and understand the grizzly's needs and behavior.

In 1967 the Craigheads' census showed that the grizzly population consisted of 202 animals. Around that time the Park Service decided to close the garbage dumps. The agency felt that feeding bears was unnatural and was "creating an environment overpopulated with bears." The Craigheads warned that the grizzlies were a fragile species and that a slight change in their habits could cause their numbers to plummet.

Between 1969 and 1970 all the dumps were closed, and by 1973, 189 grizzlies were killed. Their crime was entering campgrounds in search of the garbage they were accustomed to eating. In 1980 only 46 bears were counted in the park. Did the Park Service make the right decision to reestablish a population of bears independent from man? Today "there isn't a single bear alive that was alive when the dumps were here," admits Superintendent Barbee.

Frank Craighead still believes that the grizzly should be lured away from populated areas by placing carcasses in remote areas. He feels a constant source of high-quality food would also increase reproduction and decrease mortality of the grizzlies. In the meantime the Park Service will continue to protect the grizzly by closely monitoring its population. As long as its numbers are not in jeopardy, the bear will remain free roaming.

SCIENCE AND THE FERRET

Some creatures need more help from humans than others. Sometimes the fate of an entire population requires complete human control to prevent a species from vanishing. The most endangered mammal in North America—the black-footed ferret—was nearly lost. Science enabled the species to recover.

Fundamental to any species' survival is its ability to produce offspring. With the help of two wildlife veterinarians deep in the hills of Sybille, Wyoming, the ferret is doing this. Don Kwiatkowski and Tom Thorne do everything from monitoring breeding sessions to collecting and freezing male sperm.

To help the male ferrets become good breeders, they 'practice' with semidomesticated Siberian polecats. Male ferrets are fertile about four weeks before the females, and according to Kwiatkowski, "The more the males are bred, the better breeders they become." Kwiatkowski, who lives in a small trailer less than 100 yards away from the ferret compound, is guardian of the ferrets 24 hours a day, seven days a week.

When the female ferrets are in heat, the marathon begins. Ferrets can injure one another during sex (the females are especially aggressive), so Kwiatkowski and Thorne have hooked up video cameras and microphones to each cage in the long, narrow rooms where the ferrets mate. Thorne and Kwiatkowski keep a 24-hour watch on the animals during the mating season. The researchers also observe the ferrets to study their behavior during mating and make sure breeding occurs. While Thorne sleeps on a small cot in an environment as sterile as an operating room, Kwiatkowski keeps a vigil on the ferrets. While Kwiatkowski sleeps, Thorne keeps watch.

During the 1987 breeding season the two veterinarians spent 100 days and nights watchdogging the ferrets' lovemaking. The vigil was reduced to 25 days and nights during the 1988 breeding season, and this year's monitored sessions are expected to be even shorter. Thirty-four kits have survived from 44 babies born to 13 litters in 1988, and seven of eight kits survived in 1987. The veterinarians believe that the 1989 breeding season will produce even more kits. Thorne and Kwiatkowski are just two of the hundreds of people who've contributed to the ferret's survival. Their supporters include nutritionists, fertility specialists, chemists, geneticists, field biologists, and concerned citizens.

No black-footed ferrets are known to exist in the wild, though researchers are still hoping a colony will turn up in Montana. Many sightings have been reported in Wyoming, but all have turned out to be false alarms—prairie dogs whose faces have been accidentally blackened by coal deposits in their burrows. "Tracking down reported sightings of black-footed ferrets is worse than trying to find the Tasmanian tiger," admits Tim Clark, a wildlife biologist at Idaho State University, who often responds to the reports himself. Clark has spent 15 years in the field looking for black-footed ferrets.

The chance of finding another colony of ferrets is less than 1 percent—yet the New York Zoological Society has offered a $5,000 reward to anyone who happens upon a black-footed ferret. If a new colony of ferrets is discovered, it will have been isolated from any other ferrets for 30 to 50 years. The genetic makeup of a new colony would be very different from that of the Sybille colony. A chance to introduce a varied gene pool would obviously help ensure the species' future.

THE CHEETAH AND EVOLUTION

The black-footed ferret could not have survived without the aid of man and science. Nature could no longer sustain the species. In some instances, however, nature has been able to heal itself. Like the black-footed ferret, the African cheetah suffers from a limited gene pool. Yet the cheetah has survived for hundreds of

years with ten to 100 times less variation in its genes than most big cats

The cheetah apparently suffered a dramatic reduction in its population hundreds of years ago "As the cheetah went through this population crisis, its detective genes were wiped out The species came through the crisis genetically homogenous, with far less genetic variability but with the detective genes so reduced in numbers that inbreeding could proceed without substantial loss to the species," says E O Wilson, the renowned evolutionary biologist

Stephen J O'Brien, a geneticist at the National Cancer Institute in Frederick, Maryland, and other geneticists agree that even when a population is reduced to just seven individuals the species can still retain 95 percent of its genetic variability The cheetah was reduced to a few individuals by one or more events such as a drastic climate change a viral or bacterial plague, or loss of habitat

In addition to reducing the cheetah's numbers, the squeeze on the gene pool also resulted in a high infant mortality rate and left the species more vulnerable to disease And even though the cheetah is the world's fastest animal, reaching speeds of up to 70 miles per hour, today's cheetah can run only a few hundred yards before collapsing from exhaustion, says O'Brien "This weakness" has developed over hundreds of years

In an experiment conducted by O'Brien, dime-size patches of skin were exchanged among 12 unrelated African cheetahs In cats domesticated as pets such grafts are rejected within seven to ten days The patches exchanged among the cheetahs grew together and healed, as if the cheetahs were identical twins The genetic makeup of the grafted animals was identical and likely represented the entire population

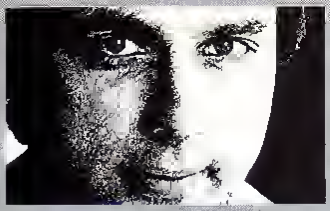
This proves that even though some animal populations have been reduced to very small numbers, which drastically limits their gene pool and makes the species more vulnerable to environmental changes, the species may still be restored to an adequate population Furthermore, the species may exist for hundreds or even thousands of years

Since the cheetah's first population crisis is estimated to have occurred 10 000 to 12 000 years ago, natural selection—the evolutionary process by which the least adaptable individuals fail to survive—has surely by now eliminated the most detective genes in the population

Unlike the cheetah man cannot run 70 miles per hour, but the automobile can easily surpass this speed Unlike the mountain lion the wolf, and the grizzly, man cannot hunt with his bare hands, but we have developed ways to manipulate livestock through farming and ranching Unlike the northern spotted owl, we cannot fly freely but we have devised technology that allows us to soar in contraptions far faster than any bird Unlike the black-footed ferret, we cannot wiggle our bodies into underground colonies but our homes are built above and below ground with some of nature's finest products Unlike any other creature on Earth man has an intellect. Nonetheless, there is a bond that ties all life forms together The relationship between man, the forests, the northern spotted owl, the black-footed ferret, the cheetah, the many species of butterflies, the plankton in the oceans, the grizzly, the wolf, and the mountain lion—all plants and animals—is a delicate balance of interrelationships critical to every species' survival

"Not only do we need the resources that nature provides for our daily needs, but our state of mind requires the presence of the natural world to live up to our fullest capacity," says Wilson "Our connection with nature runs deeper than most members of the human race appreciate, acknowledge, or understand

Man is in a unique situation We are the first thinking species that has evolved on Earth and we literally dominate the world We have the opportunity to mold the future of all life forms—by taking the present into our own hands. DO



LAST WORD

By Mitch Coleman and Dave Jaffe

"This could be the discovery of the century, the Rosetta Hide-A-Bed, the missing archaeological link, the innovation that finally brought mankind out of the Dark Ages and into well-lit showrooms."

Under a broiling desert sun, thousands of laborers toil with pick and shovel carefully unearthing the remains of an ancient civilization that had once flourished on this Egyptian plain. Suddenly from a remote corner of the site comes a cry in Arabic. The call is picked up by others and soon a thousand voices are screeching in nearly as many tongues.

Workers throw down their tools, scurry barefoot across the rock and gather around the newly discovered artifact that stands godlike before them.

Although covered with the dust of millennia, there is no mistaking its unique shape. One laborer steps forward and slips his fingers under the gray, dusty mass. Carefully he feels along its edges for the indisputable proof that will confirm the importance of this find.

His fingers probe quickly, then stop. Slowly he draws forth a small piece of ancient papyrus. Carefully unfurling it, he translates the hieroglyphics: "Do not remove this tag under penalty of law."

After just a few minutes a cable is dispatched to London to the office of Professor Milo Zatz, the world's foremost authority in archaeological furniture studies—better known as armchair archaeology. Objects found by removing the cushions and groping into the crevices below can help unlock the secrets of lost civilizations.

Although seventy-one years old, Zatz doesn't hesitate for a moment. He immediately books a flight to Cairo, packs his bags and 20 hours later is riding a camel on the rugged trek to the site.

"We've learned so much about ancient people by studying what fell out of their pockets and got caught between the cushions," Zatz remarks. "For one thing, we've learned they had pockets!"

Zatz achieved notoriety in the field of armchair archaeology in 1970 with the publication of his book *Chairs of the Gods*. According to Zatz, interior decorators from another galaxy visited the earth some 4,000 years ago and "did some really fabulous things with fabrics." Since 1973 every major archaeological excavation has called on Zatz to probe ancient comfy seating.

Reaching the dig just before dark, the professor dismounts and proceeds to examine the object carefully. "This is an old one," he says. "Looks like a Barca lounger made from real bark. Probably from the home of an Egyptian prince."

As he pulls off the cushions, Zatz explains that furniture is like an excavation site in that it has layers of artifacts, corresponding to different ages.

"If I reach to the bottom," he adds, slipping his arm deep into the chair, "I can find objects lost while the owner was a baby. If we're lucky we can trace his entire life through artifacts recovered from this single piece of furniture."

With a tug, Zatz produces a cylindrical piece of wood about ten inches long with notches cut in each end and in the center. "Lincoln Logs," he explains. "They were somewhat popular during the reign of Tutankhamen. They never really caught on because they predated Abraham Lincoln by about three thousand years."

Next Zatz pulls up a dog-eared papyrus magazine featuring partially clad models. He gives it a quick scan. "*Tuts and Asp* magazine," he shouts, slipping it into a plastic bag. "Obviously this is from his teenage period."

As the search continues, Zatz pulls up a number of objects: a comb, of course, and a hairbrush, some coins, then an interesting succession of things—a wine cork, a burned candle, some bread crumbs, and finally, a scarab earring. "Now we're getting somewhere," Zatz says triumphantly. "These relics will indicate what happened to the prince on the last day of his life—or at least on his last date."

Laying the objects in a row at his feet, the gray-haired archaeologist sets about reconstructing the final moments of the Barcalounger and its princely owner. "The way I see it, he invites a girl over for some music and wine, maybe a little dancing. She shows up about 7:15, they drink, he makes a play for her, she loses her earring, and then..."

An excited assistant pipes up, "And then what?"

"Lava," Zatz says sadly. "The entire civilization was entombed in lava. Ancient civilizations are always buried in lava. Don't you watch TV?"

A look of wonder crosses the old man's face as he gently pats the arm of the dusty lounger. He sighs, "If only this furniture could talk."

Zatz stops in mid-sentence as the arm of the lounger gives way, triggering a hidden switch. From deep within the chair comes the sound of sifting sands and a creaking of ancient gears. "Good Lord!" he shouts as the recliner begins to transform. "This could be the find of the century—the Rosetta Hide-A-Bed—the missing archaeological link that brought man out of the Dark Ages and into clean, well-lit showrooms!"

Crawling gingerly onto the mattress, Zatz tests the springs. With a sinister *sproi-i-ing* the Hide-A-Bed slams shut, trapping the elderly archaeologist inside.

Dozens of anxious workers crowd around the hellish recliner but are unable to release Zatz. Finally the foreman shouts for the noisy throng to be quiet. He kneels and, pressing an ear to the furniture, hears the rhythmic tap of a claw hammer. Zatz is alive!

"Are you injured?" the workers ask.

"No," answers Zatz, in a voice bold with courage, "but is there a reupholsterer in the house?"

Mitch Coleman and Dave Jaffe are two of Chicago's funniest furniture salesmen.