OMNI

MARCH 1992

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VOL 14 NO 6 MARCH 1992

DEPARTMENTS

What did dinosaurs look like? Paleontologists and non-scientists alike have their own visions of the creatures, including Hajime Sorayama (The Image Bank), whose toothy monster claims our cover (Art and photo credits, page 53)

FEATURES

OMNI (ISSN 0149-8711) is published monthly in the United States and Canada by Omni Publications International Ltd., 1965 Broadway, New York, NY 10023-5965. Second-class postage paid at New York, NY, and at additional mailing offices. POSTMASTER: Send address changes to Omni Magazine, Post Office Box 3041, Harlan, IA 51537-3041. Volume 14, Number 6. Printed in the USA by Meredith/Burda Corp. and distributed in the USA, Canada, United States territorial possessions and the world (except the UK) by Curtis Circulation Company, 433 Hackensack Avenue, Hackensack, NJ 07601. Distributed in the UK by COMAG, Tavistock Road, West Drayton, London UB7 7QE, England. Subscriptions U S A/FO—$24 one year. Canada and elsewhere—$28 one year. Single copies $3.50 in U.S. A/FO and Canada. Telephone 1-800-289-6664.

FIRST WORD

THE CHARISMATIC MEN'S MOVEMENT
Warrior wannabes, unconscious deals, and psychological booty

By Carol Bly

Like all deals warriors make with each other, Bly says, the real issues are not manliness, love, male bonding, and all the glitter about honor, they're about booty.

We need to divide the men's movement into its four quite different components the genuine psychotherapeutic turnaround for men (for example, work described by Murray Scher, Mark Stevens, Glenn Good, and Gregg A. Eichenfield in *Handbook of Counseling and Psychotherapy with Men* Sage 1987), second, the workplace networking against women—in which men link arms all the way from Elm Street (Yale's secret society lane) to Bohemian Gardens in a moneyed network that keeps the easy sitting-on boards dollars away from women, third, the half-conscious psychological phenomenon which, although described as male bonding at weekend retreats, is really back-to-nature yearning, and fourth, the charismatic movement, which is dangerously made up of unconscious material in its leaders which arcs across to unconscious material in its followers.

A word about the back-to-nature component first. John Naisbitt, in *Megatrends*, warned that as culture got higher and higher in technology people would surge more and more into high *touch* activity. We saw the first of it in the down-home communes where the college-grad women baked whole-wheat bread all day. In the 1990s there is a worse aspect of the high-touch yearning. We now know we have wrecked much of our planet, and we are afraid that corporations and large social instruments of one kind or another will wreck the rest of it. This unconscious grieving for nature, bent as it is in the men's movement mold, is pathetic, but not likely dangerous.

It is the fourth aspect of the men's movement which is dangerous. This is the excitement based on the *unconscious* feelings of charismatic leaders. People adore leaders when they can't solve their own psychological problems. It is absolutely natural. First you whine, then you link with a leader, and then you get high on the leader but find the high evaporates when he leaves the room. The leader has his unconscious needs, too. He gets high because he can formulate conversations that excite followers. Then they need him. If the leader's unconscious feelings are a) misogyny and b) self-satisfaction (and most charismatic leaders have a huge steam of misogyny and self-satisfaction in them), then those feelings whip over to the followers and link up with *their* misogyny and then—here is the switch—their feelings of self-dissatisfaction.

It is a deal between one subconscious and the other. It is, in the case of the men's movement, an unconscious deal between a big-time warrior wannabe and a wimpy warrior wannabe.

I use this warrior language with bemusement. It is the language of the pop part of the men's movement. It is the language, too, of those men who have called me up late at night to exclaim, "Don't you understand?—we don't want to be soldiers! We want to be warriors!" Archaic language is part of psychological coverup—that's why Nazis pulled in so much Nordic-God claptrap. It is why in one early and embarrassing corner of the women's movement people went around talking about earth mothers and ancient dance.

Sticking with warriors for a moment. The old Saxon poem *The Wanderer* has a wimpy warrior whining because his lord is gone and the great days of kneeling to the lord are over. Then the poem goes on to ask, "And where will the gold come from *now*? The booty?" It turns out that the wimpy warrior loved the boss all right, but he loved the deal, too. Warriors don't go to battles without promise of booty. A good thing to remember if you take up warriorship. It invariably involves idleness while other people clean up the camp and care for children, *and* if you scratch the adoration of the leader, you find love of booty. So much for warrior grit.

If thousands of men are describing themselves as warrior-novices, what is the booty offered them? It is Psychological Comfort Where There Has Been the Beginnings of Discomfort.

Here is the unconscious message—sent unconsciously by the leader to the follower:

1. I promise to get the conversation back onto men and only men, the way it used to be before the women's movement.

2. I promise that the human condition is static. Although Plato warned people not to read myths as if they described ethically admirable character, we will do it anyway. We will stick by myths and fairy tales because then we don't have to change.

Now *that* is what gives the men's movement flare, and makes it dangerous. ∞

EARTH

ICE PAX

A Soviet-American research team weathers the rigors of Antarctica

By Billy Allstetter

Will icebreakers lead the way to understanding global change?

Explorer Sir Ernest Shackleton's hopes of crossing Antarctica were dashed in 1915 when an ice pack trapped and then crushed his ship *Endurance*. Shackleton and his crew endured more than a year on the drifting ice before escaping in small boats to the South Shetland Islands. Amazingly, everyone survived. But no one has ventured back to the western Weddell Sea—until now.

In February a Soviet-American team ventured into this inhospitable region for the first time in 77 years. Researchers plan to climb onto an ice floe to conduct four to six months of oceanographic research. Their goal: to discover crucial clues to the earth's climatic future held in the waters east of the Antarctic Peninsula.

The project could not come at a better time. No one questions the fact that accumulating greenhouse gases will trap more of the sun's energy. The debate heats up when people try to predict how the earth will respond.

Scientists know that the oceans absorb heat in the tropics and then vent it into the atmosphere in the polar regions. Off Antarctica, deep ocean water wells up to the surface where the air chills it to -2 degrees centigrade. The chilled water then sinks to the ocean bottom and circulates throughout the world.

Ice plays a pivotal role in the process. It serves as an insulating blanket, keeping the ocean's warmth from escaping into the atmosphere. Changes in the polar ice cover could affect the exchange of heat between the deep ocean water and the atmosphere and thus change the earth's climate. More ice cover would hold heat in the ocean, producing a warmer ocean and cooler atmosphere. "Any warming of the deep ocean could moderate the greenhouse effect," says Arnold Gordon, the expedition's American team leader and professor of oceanography at Columbia University's Lamont-Doherty Geological Observatory. "Less ice would have the opposite effect, enhancing the greehouse effect."

Unlike the Arctic ice pack, which is relatively stable and well understood, the Antarctic is neither. Ice forms only during the winter months in most of the waters off Antarctica, and the amount varies from year to year. "Relatively small changes in either the atmosphere or ocean can lead to a significant change in the Antarctic sea ice cover, which in turn can have a major impact on the climate," says Douglas Martinson, a Lamont-Doherty oceanographer who will make the trip.

The key is figuring out which changes trigger what effects. Researchers on Soviet and German icebreakers have already gathered valuable information about the interactions between ocean, air, and ice during three trips into the winter ice cover. But the western Weddell remains a big mystery. Why does ice stay there year-round? And why does water cool as it flows northwest under the insulating ice cover?

Only such nagging questions could tempt scientists into the world's most hazardous region. Because the ice is so thick that icebreakers can't penetrate it, the only solution is to follow Shackleton. Climb onto an ice floe at the southeast edge of the permanent ice cover and drift with it 400 miles northwest through the western Weddell Sea.

With modern technology, the expedition should be less harrowing than Shackleton's, but it will be no stroll in the park. In addition to the harsh climate, minimal medical facilities, and long distances to civilization, the team faces the extra hazard of an unstable campsite drifting far from terra firma.

Even so, the potential for scientific discovery seems worth the unusual risks. "This is going to be extraordinarily useful in predicting the changing climate of the earth," Gordon says. ∞

COMMUNICATIONS

READERS' WRITES:
Life is inspiring in *Star Trek*, horrifying in Guatemala, and artificial in computers

Boldly Going On

I was pleasantly surprised to see the image of the *USS Enterprise* adorning your December 1991 issue, as I was equally entertained by director Nick Meyer's article on his dealings with the *Star Trek* phenomenon. Unfortunately, Melinda Snodgrass accompanying article on *The Next Generation* struck a sour note. I consider myself an intelligent professional. I do not wear pointed ears to bed, nor have I memorized the combination to Jim Kirk's personal safe. But I do enjoy both series of *Star Trek* and have learned to appreciate Gene Roddenberry's vision. While crediting the original *Star Trek* with having an impact on society, Snodgrass downplays that by stating it reflected rather than shaped, the country's attitude. In fact, the original show attracted the attention of Martin Luther King, Jr., who urged Nichelle Nichols to stay with the show as a role model for black women. It inspired the careers of young viewers, like the future doctors who wrote letters to DeForest Kelley. And it made us think optimistically both about ourselves and the future. *Star Trek* is not about "the effect the technological gimcracks have on people"; it's about people. The conflicts presented on both shows are not new; they are conflicts we face every day. The technology and the aliens provide an environment that lets us view these issues in a different, and sometimes more objective, light. Yeah, I know, it's just a TV show. But it's a show about characters I care about, and it makes me think. How many TV shows can boast that?

Adam Bernard
Southfield, MI

Rock the Cradle

Concerning the dynamic article on state-supported child abuse ("Suffer the Children," November 1991), I would suggest to the author, W.E. Gutman, that overpopulation does not rape, torture, and mutilate children. Rapists, torturers, and evil people do. Reducing the number of victims does not make crime disappear; it makes the statistics less overwhelming. The first surgical procedures that came to my mind after reading the article were not contraception or abortion of tomorrow's victims, but the emasculation of today's oppressors. If a nation can go to war for "a way of life," surely it can wage economic and political war for life itself. This nation is blessed to have people with the guts to photograph, write, and publish such articles. Thank you for printing the names of organizations that are making a genuine effort.

Cameron Bobro
Santa Cruz, CA

I have never seen an article in any magazine more important than your article on state-supported executions of children. As a long-time subscriber of *Omni* as well as a member of Amnesty International, I am happy to see these organizations work together to expose international human rights violations. Thank you for having the courage to print the truth about the treatment of these children and the indifference of their governments and ours to the plight. You are also right in pointing out that preventing people from access to birth control ensures that they will have more children than they can care for. Keep up the great work!

Kathleen Perez
Lanham, MD

Temper, Temper

As usual I enjoyed your anniversary issue (October 1991). However, Chris Langton's comments [Interview] were frightening. The work he is doing, creating artificial life in a computer, lacks one serious element. What good is it to create a life that has no emotion, no heart, no awareness of good and bad? Langton says, "Any definition of life we might make based solely on our own experience of life on Earth will be too narrow." But, isn't that speculation too awesome to challenge? I hope Langton goes slowly, tempering emotion with the life form.

Katharyn Brown
Sarasota, FL

ARTIFICIAL INTELLIGENCE

SILENT SCREEN

Screenwriters turn to software for help in fine-tuning scripts

By Steve Ditlea

FADE IN: SCENE: A major television awards show. The screenwriter stands behind the podium, clutching a gilt statuette and effusively thanking friends, family, and God for their support while writing the screenplay that has swept all the major awards tonight.

But the screenwriter fails to mention that the screenplay was a joint effort. The collaborator goes unnoticed, sitting quietly at home on a paper-strewn desk in a dark house. The much-honored screenwriter wrote the screenplay in question with the help of a computer program.

This could be the beginning of a beautiful friendship: Screenwriting programs ask all the right questions and never demand a percentage of the gross.

It's just a matter of time before a personal computer collaborates on the structure and plotting of an Oscar- or Emmy-winning script. But even the authors of the software don't expect their creations to get the credit they're due. The opening sentences of the manual for *Collaborator*, a program for Macintosh and IBM PC compatibles that's published by Collaboration Systems of Sherman Oaks, California, emphasize that one advantage of a computerized writing partner is not "having to acknowledge him in any way, publicly or financially."

Television writer and novelist Virginia Browne, who confesses she's 'never had a successful partnership with a human,' has written five scripts (including an adaptation of Danielle Steele's novel *Daddy*) with *Collaborator* on her computer. "It's great," Browne says. "There are no personality conflicts—and no arguments over where to eat lunch."

The program, an interactive aid for plot and character development, asks 70 key questions necessary for box-office or ratings success.

Applying the kind of specialized knowledge found in artificial-intelligence programs known as "expert systems," *Collaborator* is the first commercial software based on the ideas of a human expert who died over 2,300 years ago. "About three-quarters of *Collaborator*'s questions are based on Aristotle's six elements of drama," explains Francis Feighan, codeveloper of the program. "All of the basics of drama in Western civilization were worked out by Aristotle—like the three-act structure with a beginning, middle, and end." The rest of *Collaborator*'s questions are derived from the theories of Lajos Egri, whose *The Art of Dramatic Writing* has been a fixture on Hollywood writers' bookshelves in recent years.

Collaborator began with the desire of former movie reviewer, studio publicist, and TV soap and series writer Feighan to create a computerized check list of everything he needed to keep in mind when plotting and writing a screenplay. Together with partners Cary Brown, a director for ABC-TV sports, and Louis Garfinkle, who wrote the original script for *The Deerhunter*, Feighan first worked with a programmer in LISP, and then Feighan and company started over in the compact C language. "If you don't have talent, *Collaborator* can't help you write a good screenplay. It will never replace anyone in the Writers' Guild," says Feighan, referring to the screenwriters' craft union, some members of which have already expressed opposition to software that could someday compete for their livelihood.

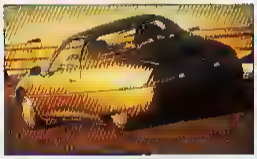
Meanwhile, almost all of the display advertising for computer software in the Writers' Guild Journal is for computer-assisted screenplay programs. In addition to *Collaborator* and script formatting software, there's even a program called *Plots Unlimited*, a data base capable of generating movie plots with up to 200,000 different theme, character, and conflict combinations. As with any attempt to systematize a creative pursuit, *Collaborator* and its ilk may well result in writing that is formulaic. "Too formulaic for television? Excuse me?" says TV veteran Browne. ☐☐

WHEELS

ALTERNATIVE ENGINES.
Sputtering to life after years of experimentation

By Jeffrey Zygmont

On a fine spring day in 1982 I was driving a Cadillac *Eldorado* that ran out of coal. It was a General Motors test car powered by a turbine engine burning pulverized anthracite. Such things were common in that era of wild experimentation, when the rise of environmentalism plus two severe oil shortages in the 1970s had the automobile industry scrambling to replace gasoline engines.



Gone is talk of steam power, it's clean, but forget ever trying to pass a hay wagon on a country road

Ten years later, alternative engines are at last sputtering out of the garage. The latest California clean-air laws, now spreading to other states, demand that auto companies offer some zero-emission cars by 1998. Thus Ford and Chrysler are laying plans to produce mainstream battery-powered automobiles. General Motors has already assigned a Lansing, Michigan, factory for its *Impact* electric commuter car. In Los Angeles, the Swedish company Clean Air Transport is perfecting its electric auto under the LA Initiative, which aims to put 10,000 electrics on city streets by the late 1990s.

All told, you should be able to buy a battery-powered automobile by at least 1995. Wait another decade or so and you may get a turbine-driven car fueled by hydrogen, natural gas, alcohol, gasoline, maybe even liquefied coal. Yes, it's adding up to be a long wait. But after years of dreams and experimentation, engineers have honed away impractical engine options.

Today, development focuses on alternatives that promise to improve both the quality of auto motoring and the prospects for energy use and the environment. Electrics create *no* emissions. Jet-like turbine engines are clean burning and durable, and they accept a diversity of fuels. Also to come are hybrid vehicles that combine electric drive with small internal-combustion engines to keep batteries charged. That engine is likely to be a two-stroke power plant. A derivative of the four-stroke engine used today, two-strokes can pack more power into a small package. For that reason they'll probably soon replace some four-strokes altogether, providing better gas mileage and sleeker, more aerodynamic hood lines.

The early alternatives, however, won't meet the expectations of drivers conditioned to today's autos. Current batteries get fewer than 100 miles between recharges, keeping them only on predictable routes like the daily commute to work. To find remedies, car companies recently created the U.S. Advanced Battery Consortium. "Its target is to complete the R&D necessary for several advanced batteries by the middle nineties," says Richard Schweinberg, manager of electric vehicles at Southern California Edison, an LA Initiative sponsor. Also in development are quick-charge batteries that cut the overnight recharge period. Work in Japan is yielding batteries that replenish 40 percent of their energy in about ten minutes. Another scheme to extend range is the roadway-powered electric vehicle of the Institute of Transportation Studies at Berkeley's University of California. It charges electric vehicles on the move with coils embedded in the road.

Technical hurdles are delaying other engine technologies even longer. Before hybrids are feasible, scientists must perfect the power-switching electronics that will mesh engine with battery. Two-cycle engines, though favorites for the auto industry, need better fuel-injection systems to meet pollution regulations. And they aren't yet durable enough.

Turbines are awaiting the development of advanced ceramics to withstand devilish heat while rotating at about 100,000 rpm, explains GM executive engineer Dave Dimick. Moving parts in a turbine get as hot as 2,500 degrees Fahrenheit. The metal that lines today's gasoline engines gets no hotter than 1,000 degrees.

Of course, all such development is costly. That will make new engines comparatively expensive at first. Clean Air's auto should sell for about $25,000 when it appears in 1993. General Motor's *Impact* shouldn't cost any less than that.

"With electrics, we're probably going to have to play some games with government policy because they're not going to be economic," says David Cole, head of the University of Michigan's Office for the Study of Automotive Transportation. In California you can already get a $1,000 tax credit if you purchase an electric car. Electricity rates are cheaper if you recharge at night. Add to that the knowledge that you're doing something for the environment and the future of the planet—enough to attract the zealots at least.

"It's the beginning of a long journey, but we've got to take the first step," says the utility executive Schweinberg.

BOOKS

SEEKING THE FUTURE IN THE PAST
Two "cyberpunks" take a trip through history

By Robert K. J. Killheffer

Word around the science fiction community these days, particularly from readers and authors who cut their teeth in the forties and fifties, has it that there is something missing in contemporary science fiction. Maybe they're right. *The Difference Engine* by William Gibson and Bruce Sterling, recently released in paperback by Bantam Spectra, displays a new ethos found in many other recent science fiction novels.

The Difference Engine portrays

Though set in an alternate past, the latest book by Gibson and Sterling says more about the state of today's science fiction

the Victorian era as it might have been if the steam-powered gear-laden "analytical engine" designed by Charles Babbage had actually worked—in other words, *if the computer had been invented some hundred years ahead of time*. This perfectly respectable science-fictional idea allows the authors to explore the effects of technological innovation on human society, history, and individual lives. But the underlying attitudes toward science and technology in *The Difference Engine* illustrate some major changes that have occurred in science fiction over the last 40 or 50 years.

In the heyday known as the Golden Age (circa 1938–1945), when many of the genre's greats such as Asimov and Heinlein were getting started, science fiction was largely characterized by an attitude inherited from the earliest days of the Industrial Revolution, when steam power, railroads, and other marvels seemed capable of solving every problem. "We presuppose two things," wrote one of the most influential figures of the Golden Age, John W. Campbell, Jr., editor of *Astounding Science Fiction*, "that there is yet to be learned infinitely more than is now known, and that man can learn it." Onward and upward, science would be the salvation of humankind. In Gibson's and Sterling's book, on the other hand, Babbage's Difference Engine improves life—for instance, better agricultural methods devised by the machine prevent the Irish famines of the mid 1840s—but it also creates drawbacks the Golden Agers would not have admitted. Uncontrolled pollution spreads a fetid cloud, "the Stink," over London, and the government is already using the computing power of the Babbage Engine for surveillance and oppression of the populace.

Since the days of the Golden Age, we have seen technology fall short of our hopes. Nuclear power has produced nightmare weapons but not the atomic cars and appliances foreseen in the 1950s; environmental abuses have grown from nuisances into visceral terrors; visions of 20-hour workweeks and robot housekeepers have vanished in a haze of 24-hour offices, smog, and overpopulation. While still recognizing technology's potential for good, *The Difference Engine* admits the likelihood of unforeseen complications and side effects of technological advances.

The Difference Engine also reveals a more recent attitude change—questioning not only the practical uses of science, but the limits of knowledge itself. A mathematical genius strives to create a program called the Modus, which will predict the outcome of random events—and thus prove that science can define and control any situation, even the vagaries of chance. But the program fails, and the programmer must admit by the end that "there is no finite mathematical way to express the property of truth." During this century, the theories of Einstein, Gödel, Heisenberg, and others have made the Golden Age's firm faith in the unlimited potential of human knowledge less tenable. Heisenberg's Uncertainty Principle shows that there are strict limits to our ability to discover *everything*. The speed of light seems an unchallengeable absolute velocity. Subatomic particles once thought indivisible have revealed a still unplumbed array of ever-smaller components. *The Difference Engine* reflects this sense that science cannot entirely encompass the mysteries of the universe.

Perhaps dramatic new successes in deciphering the mysteries of creation will spark more grand, optimistic visions of the future, or maybe our collective experiences this century have yielded a cautious maturity that will forever color our perceptions of science and technology. Either way, *The Difference Engine* makes it clear that science fiction will be with us, weaving our attitudes into fictions that speak to the modern mind. Even when it carries us to the past, science fiction will lead us into the future. ◻◻

POLITICAL SCIENCE

TRASHING MEXICO: Free Trade or Free Ride?

By Tom Dworetzky

Once in hard, beautiful Colombia the ravages of Third World environmental devastation were brought home to me as I watched a ten-year-old girl in a miraculously spotless white dress. Done with morning chores, she danced about in the ankle-deep juices that ran everywhere in the village patchwork of huts rutted into the valley bottom. Hopping on slippery stones through a nasty brew of waste and slag-water from the coal mine up the valley, she managed to keep that white dress clean. She was sickly, as were most of the other children. The little boys in the village, already working in the mine, I was told, even now suffered the lung ills associated with coal dust.

Television footage recently reminded me of the girl. It showed one of the shanty towns where $1.40-an-hour laborers struggle to get by in the trade zones along the Mexican border abutting the United States. Today, about 2,000 multinational facilities located in specially designated areas within 100 kilometers of the border—so called maquiladoras—already crank out $4 billion a year and are Mexico's second largest cash cow after oil. The Bush administration proposes expanding this trade arrangement with a new North American Free Trade Agreement now being negotiated by representatives of both nations and Canada. It would basically open up all of Mexico to the same opportunities.

Sure, the money's lousy, the work is hard, but if you're an impoverished worker in a broke country, even this type of economic colonization sounds, on the surface, like a better deal.

Except that these factories' record of the last 25 or so years suggests their benefits come with a hefty environmental price tag. The maquiladoras appear to be trashing the local water, air, and land—and saving companies tons of dough on compliance with those stupid U.S. environmental regulations. Mexican law is pretty stiff too. It requires that toxic wastes (like used solvents) should be returned to the country of origin. Since the stuff is imported from the U.S., that means us. But even the more generous estimates, according to San Francisco–based Kathleen Shimmin of the Environmental Protection Agency, would leave as much as two-thirds unaccounted for. "The general idea is that there's a lot going out of the U.S., and much less coming back," she says. Brent Blackwelder, president of Friends of the Earth–USA, testified before the House of Representatives last fall that air pollution from the maquiladora industries is so bad it's impinging on areas as far north as the Grand Canyon.

Yet EPA's Shimmin is "cautiously optimistic" about the Agreement, arguing that the money it brings will enable Mexico to hire more inspectors. Moreover, enforcement of the Mexican pollution laws is something the Bush administration has promised to promote. Of course, this is the same administration that made a raft of domestic "green" promises that have wilted in the face of perceived economic necessities.

We probably won't hear much about this business until after the elections. Its potential to increase the flow of jobs offshore alone makes it one hot election potato. But during Bush's second term (Am I being presumptuous to assume he'll be reelected?) the trade pact will probably go through. Domestically our green-backing President has turned out to be talking more about the color of money than the color of nature. For the sake of Mexico, let's hope that his foreign green promises are environmental—not just economic—and that somehow during pact talks Mother Nature doesn't fall further victim to the fast-buck shuffle. ∞

A wonderful thing for Mexico? Multinational factories in free trade zones pump out toxins. Here, the severely polluted New River at the California-Mexicali border.

ELECTRONIC UNIVERSE

EDUTAINMENT.
A growing genre of software makes learning fun-damental

By Gregg Keizer

Bread and circuses home style, doesn't have to mean pizza and *The Simpsons*. If you have a home computer—and kids at home—you can twist the Roman tradition just far enough to squeeze in some learning while you stuff them with pepperoni.

Edutainment, not a word to speak in front of touchy educators, describes the kind of computer software in which fun takes first place, education a back seat.

Imaginative computer software games provide a fresh means for learning everything from new words to new worlds.

The idea, cynical and pragmatic, is that it takes a healthy dose of entertainment to keep kids in front of the computer screen long enough for them to learn.

The grand dame of Edutainment is a red-headed maverick named Carmen Sandiego, a harmless but egotistical culture burglar who heads a gang that steals national and international treasures. First brought to life eight years ago by Brøderbund in *Where in the World Is Carmen Sandiego?* (IBM PC compatibles, Macintosh, Nintendo), Carmen has waltzed through Europe, the USA, and time. In each of her five adventures, Carmen and her crooks walk off with things like the "Mona Lisa," the Pyramids, Ben Franklin's kite, and the Constitution. Kids play detective as they track the criminals in a geographic game that demands small doses of research and problem solving and a working knowledge of places, people and culture. Players dig up clues about the thief's next stop and then try to nab the crook before time runs out.

Even though Carmen's heading to CD-ROM, where speech, better images, and music is possible, she's showing her age. The series shares a simple hunt-then-chase plot line and takes some critical hits for its learning-through-osmosis attitude.

A bit breezier is Davidson's *Headline Harry and the Great Paper Chase* (IBM PC compatibles, Macintosh). Tied to geography and history, as is *Carmen Headline Harry* adds investigative journalism to its game. Kids spin through space and time across the U.S., from the fifties to nineties, looking for the who, what, when, and where of a news story and trying to scoop the *Diabolical Daily* reporters.

Headline Harry's game is more fun for adults than Carmen's adventures, and just as much fun for kids. The chase is still there. But Harry tosses more educational crumbs on the table, for you've got to sort out the lead story from a minor blizzard of distracting facts, keep a notebook full of quotes, and even write the winning headline of your story. If only *Headline Harry* let the kids write the story, too.

Geography's not the only subject that needs some under-the-table help. That's why The Learning Company's *Super Solvers Spelldown!* (IBM PC compatibles) is worth a look.

Spelldown bundles together three word games—a find-the-word puzzle, a crossword puzzle, and flash cards—that test children's spelling skills. But it's the spelling bee that draws kids to the screen and keeps them there. To reach the bee, kids must complete two or more of the word games, so they can't simply head for the most entertaining part of the program. What separates *Spelldown* from other spelling software is the speech—you don't need a special sound board in your PC to hear the female voice intone "Spell the word *pajamas*."

National Geographic's Mammals, a CD-ROM disc-based encyclopedia and game, offers a glimpse of Edutainment's future. You need a CD-equipped PC to play with *Mammals*, but Sony's Laser Library, a $600–$700 CD drive and disc six-pack combo, includes the disc in its lineup.

Kids have as much fun just rooting through *Mammals'* encyclopedic entries as they do playing its guess-the-animal game. Hundreds of still images of the planet's mammals, extensive articles, word pronunciations, and animal sounds combine to give kids lots of information in a multimedia package. Pick 'Sea Lion,' and you'll see its order (carnivore), habits, food, and endangered species status. Click on other icons to spot its habitat or hear it bellow.

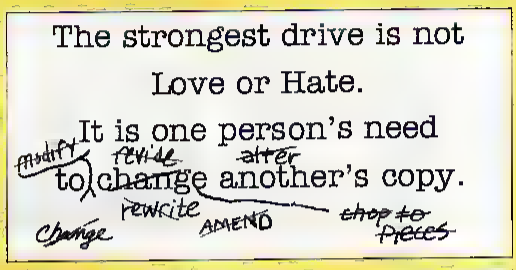
Computer edutainment is a long, long way from replacing TV in a kid's day. But its sugar-coated approach to learning is at least a start. Only when software grabs hold of an eight-year-old's attention the way Wile E. Coyote grabs for Road Runner will TV-phobic and technology-rich parents breathe easier.

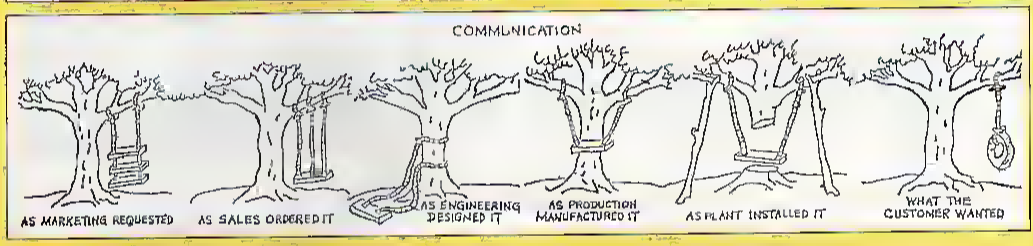
In the meantime, dangle a learning carrot in front of your kids' eyes. Maybe they'll bite.

GAMES

WORKPLACE WITTICISMS
Posting the results of Competition #53

By Scot Morris





Last April we devoted the column to modern folklore of the office bulletin board and asked readers to send in their favorite examples of this-genre

In the nearly 2,000 examples of paper lore that came in we saw many versions of the same item That was expected but it made awarding prizes somewhat difficult

I decided to give the $100 grand prize to Kenn Howard of Pittsburgh for an entry that wasn t duplicated and was new to me (top left) The following nine runners up each received $25 and a copy of my book *The Emperor Who Ate the Bible and Other Strange Facts and Useless Information* David Broome, Phoenix Arizona Cheryl Cricher, Asheville North Carolina John Hansen, Tulsa Oklahoma, Nancy LeBlanc, The Pas, Manitoba Canada, Bill Masyn Vienna, Virginia Lisa Mearing, Paw Paw Michigan David G Pierce Syracuse New York Brent Turner Orange, California and Donna T Wong, Montreal Quebec, Canada

Of the short signs and slogans submitted here are the most popular

The beatings will continue until morale improves
—The Management

SIX PHASES
OF A PROJECT
1 Enthusiasm
2 Disillusionment
3 Panic
4 Search for the guilty
5 Punishment of the innocent
6 Praise and reward for the nonparticipants

BULLETIN
The Occupational Safety & Health Administration (OSHA) has determined that the maximum safe load capacity on my butt is two persons at one time—unless I install handrails or safety straps As you have arrived sixth in line to ride my ass today, please take a number and wait your turn Thank you

Math and alcohol don t mix Please don't drink and derive (A message from Mathematicians Against Drunk Deriving)

LONESOME?
Like to meet new people? Like a change? Like excitement? Like a new job? Just screw up one more time!

NOTICE
This department requires no physical-fitness program Everyone gets enough exercise jumping to conclusions flying off the handle running down the boss, knifing friends in the back, dodging responsibility and pushing their luck

We have not succeeded in answering all your problems The answers we have found only serve to raise a whole set of new questions In some ways we feel we are as confused as ever but we believe we are confused on a higher level and about more important things

Only the truly mediocre are always at their best

NOTICE
Sexual harassment in this area will not be reported However, it *will* be graded!

When I woke up this morning, I had one nerve left, and now you re getting on it

CONTINUUM

LAWNMOWER MAN:
Adventure in Cyberfiction. Plus, killer bees reveal their identity, and a cathedral's lofty garden becomes fruitful and multiplies

We've all heard the hype about virtual reality, how it's going to change the foundations of our lives, etc etc. Now it's about to hit the silver screen with *The LawnMower Man* released nationally at the beginning of March. The film, which takes its name from a Stephen King short story, is "a cautionary tale which shows both the positive and negative potential of virtual reality technology," according to the film's director and cowriter Brett Leonard.

If stars Jeff Fahey as Jobe Smith, a gentle simpleton and gardener nicknamed the LawnMower Man, who becomes the guinea pig for Dr. Lawrence Angelo's (Pierce Brosnan) *cybertech* experiments aimed at accelerating intelligence through the use of virtual reality. "What we've done," says Leonard, "is to take the King character and adapt him to be like a Mary Shelley Frankenstein who gets transformed through VR into a kind of superhuman."

And transformation is indeed the central theme. Through a crash course of virtual reality learning and injections of a radical new "smart" drug, the simpleton quickly acquires telekinetic and psychic powers, but then all goes horribly wrong and he begins to lust for more knowledge, more heightened reality, and ultimately more power. By the film's climax he has become a complete digital cyberbeing, no longer human at all but a virtual reality monster. What starts out as a positive transformation, showing the potentially good side of VR, ends up being a terrifying tale of what might happen if the technology got into the wrong hands. According to Leonard, this is not going to endear him to some sectors of the VR community who would have us believe their toys hold nothing but good in store.

As Jobe undergoes his transformation, he is projected into various virtual reality worlds, which are entirely computer generated. Twenty minutes of the film is composed of computer graphics and digital effects. But here again, Leonard has gone out on a limb, creating what he calls a cyberaesthetic something, "totally abstract," something that could not be done with models and mattes—the traditional tools of special-effects teams. So the look of the film is almost surreal. It's a bold step to take, particularly when most films, including *T2*—although created on a computer—are designed to look as lifelike as possible. Leonard says he wanted a look that was "inherent to computer graphics." The result is something much more arty than we are used to seeing in Hollywood films, but Leonard believes that this is the way of the future for science fiction.

Three separate companies are creating the computer graphics—Angel Studios, XAOS, and Homer and Associates. Angel Studios is creating scenes in which Jobe and Dr. Angelo play an interactive VR game called Cyberboogie, a high-speed steeplechase through a series of obstacle-filled three-dimensional environments. This takes place in a fully computer-generated world in which the players are represented by part human, part futuristic cyberboogie racing machines.

While the film is *about* virtual reality, moviegoers will not be donning special glasses or headsets to see it. In this sense, it's a normal film. You will not get the VR experience of actually *being* inside a three-dimensional world, but in the graphics scenes you will see what such worlds might look like in the future. At present, most VR systems are fairly crude, but the technology is developing extremely fast. According to David C. Traub, an immersion computing expert from Centerpoint Communications who was a consultant on the film, by "looking beyond the futuristic luster of these new toys to the somewhat pained fantasies they often portray," *The LawnMower Man* will give us some powerful hints about what might be in store.

After seeing this film you're either going to be hanging out for the experience yourself or out there picketing against it. For good or evil, the age of VR is upon us—both on and off the screen.—MARGARET WERTHEIM

CONTINUUM

THE TRIPLE HELIX

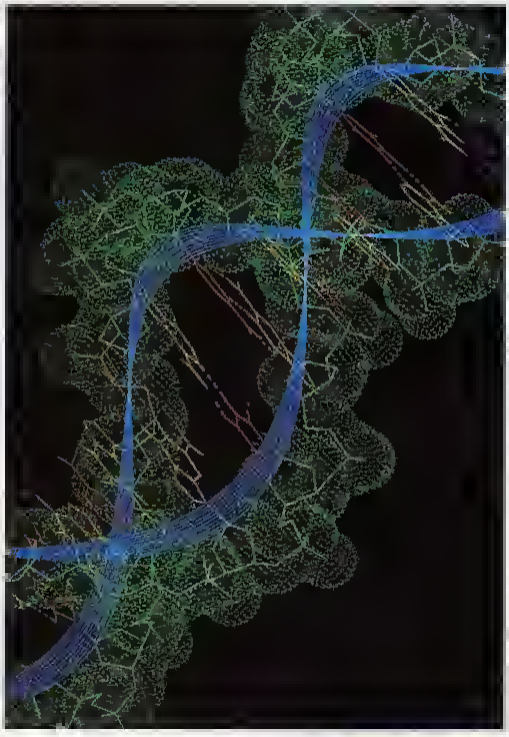
Almost 40 years ago biologists James Watson and Francis Crick took a dramatic step toward deciphering the molecular code of life when they described the structure of DNA. A "double helix," they called it—two long strands of nucleic acids coiled around one another. Now a team of scientists from Houston has learned how to wrap a third strand around the surface of the DNA molecule. The technique could lead to breakthroughs ranging from treatment for cancers and viral diseases to an elegant new means of chemical birth control.

Scientists have long known that nature left room for a third strand on the DNA molecule's surface, and since 1986, Michael Hogan of the Baylor College of Medicine has been working on building such strands from nucleic acid "building blocks" called nucleotides. The strands with which he succeeded measure only 25 to 35 nucleotides long; natural DNA strands can consist of millions of nucleotides. The new strands appear to attach neatly to genes in the nuclei of certain cells. Hogan's third strands block the action of the proteins that normally activate the genes, in effect shutting the genes down.

Hogan's Baylor colleague Bert O'Malley has shown—in test tubes, at least—that third strands can block the action of the hormone progesterone, which is essential for fertilization in the reproductive process. O'Malley plans to test these third strands in mice to see if they prove successful as a contraceptive. Collaborators at Baylor and elsewhere have obtained similar results.

The third strands might also be used to cripple viruses, such as those causing AIDS and herpes, and to block crucial genes in cancer cells, according to Hogan.

"We're not trying to alter the genes," Hogan says. "We're just making chemicals that bind to genes." Worries over long-term effects are "no different from concerns raised by ordinary drugs." —Bill Lawren



Inserting a third strand into DNA's double helix may lead to new methods of preventing pregnancy and fighting viruses

DWARF WILLOWS ARE THE WORLD'S SMALLEST TREES. THEY GROW ONLY TWO INCHES TALL ON THE TUNDRA OF GREENLAND.

DOES IT COME WITH FRUIT AT THE BOTTOM?

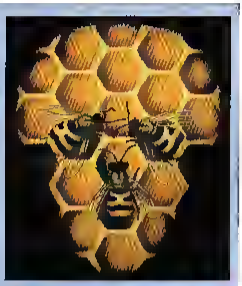
Yogurt has always been considered a health food. With the addition of a certain fermenting bacterium, it becomes *really* good for you, according to two professors at the Tufts University School of Medicine.

"There have always been health claims that certain bacteria can prolong life, make hair grow, clear up acne," says Barry Goldin, a biochemist and enzyme specialist. "So the notion was, let's add a good bacteria to a nutrient-rich food, such as milk, and see what happens."

After 15 years of research, he and infectious diseases specialist Sherwood Gorbach developed *Lactobacillus GG*, a strain of bacteria that can survive in the human intestine. (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*, bacteria commonly added to yogurt, have no proven therapeutic value.) The new strain clears up infant diarrhea in 48 hours instead of 72 hours, Goldin says. In tests of 150 infants at the University of Tampere in Finland, where yogurt is almost a national dish, yogurt made from *Lactobacillus GG* produced "a significant" cure rate. It also eliminated adult antibiotic diarrhea, common in older patients. The GG bacterium is now being studied at University Hospital in Lima, Peru, where half of all children die by age 5, often of acute diarrhea.

Lactobacillus GG may

IF IT STINGS LIKE A KILLER BEE...



Killer bees: They're definitely not as sweet as honey.

Three decades after the accidental release of African "killer" bees in Brazil, the voracious stinger has now reached southern Texas. Threatening the livelihood—and the lives—of beekeepers, the invader looks virtually identical to gentler domestic bees. To tell friend from foe, enter the "temper tester," developed by Hayward Spangler and Eric Erickson of the U.S. Department of Agriculture's Carl Hayden Bee Research Center in Tucson, Arizona.

Consisting of a bottle with a sensor inside, the temper tester measures the frequency of attacks mounted by a suspect hive. To incite the bees for the test, the operator, clothed in protective gear, blows air at the hive through a long tube and then dangles the bottle directly in the bees' path. Domestic varieties typically attack the bottle a few times per second at most. The more Africanized bees, however, attack it between 7 and 24 times per second.

The temper tester's simplicity and reliability make it ideal for use by park rangers, state bee inspectors, and beekeepers, Spangler says.

After testing the device on his African colony, Spangler counted 395 stingers embedded in just one shoe. Still, he insists the technique is safe—"when used with protective clothing."—Kathleen McAuliffe

COMPUTING WITH BACTERIA

Just as humans trace their origins to the primordial ooze, future generations of computers may owe much to the salt marshes of today. Bacteria in the marshes produce compounds that could allow computers to store an entire library's worth of information in a one-inch cube, according to Robert Birge, director of Syracuse University's Center for Molecular Electronics.

When molecules of a protein known as bacteriorhodopsin (bR) absorb light, they change color, from purple to yellow. These two forms of bR can store and retrieve information much as today's digital computers do. Such computers recall and store data by switching their numerous elements from on to off and vice versa, when intersecting laser beams hit bR arrays, the molecules similarly change state, from purple to yellow or vice versa.

Two-dimensional bR films have been around for a while. This fall, Birge announced that he had embedded bR in small cubes of plastic. "We now have access to a third dimension,' he says. "That gives you a one thousand to five-thousandfold increase in memory."

Birge's work employs two cutting-edge technologies: optical computing and molecular computing. Computers using these technologies won't be hitting store shelves for 10 to 15 years, although AT&T Bell Laboratories unveiled the first optical computer last year.—Billy Allstetter

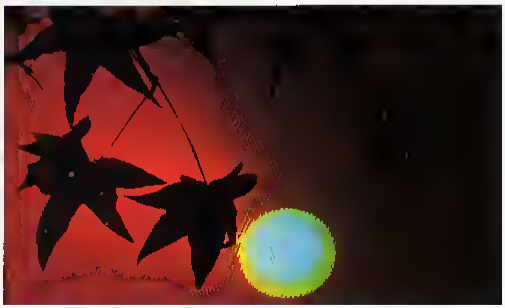
GIBBONS ARE RENOWNED FOR THEIR TREE-SWINGING PROWESS. NONETHELESS, ONE IN FOUR ADULT GIBBONS HAS BROKEN AT LEAST ONE BONE IN AERIAL ACCIDENTS.

also fight colorectal cancer. Armed with a two-year grant from the American Institute for Cancer Research, Goldin and Gorbach report that in early studies, GG bacteria reduced the average number of colon tumors in rats from 4 to 1.5. The scientists are now trying to determine at what point in the cancer's growth process the lactobacillus inhibits tumor formation.

"Colon cancer found in rats looks very similar to human colon cancer in terms of where it occurs and how it spreads," Gorbach says. "It's a clue."

"But because we don't know what causes human colon cancer," Goldin adds, "one can't conclude that what works for rats would necessarily work for humans."—George Nobbe

"Remember not only to say the right thing in the right place, but far more difficult, to leave unsaid the wrong thing at the tempting moment."
—Benjamin Franklin



Salt marshes and high technology don't seem to go together, but the marshes hold the key to a new computing technology.

CONTINUUM

A HEAVENLY GARDEN

New York City environmentalists have, as the song says, found their paradise up on a roof. Biologists at the Gaia Institute, located at the Cathedral of St. John the Divine, are finalizing plans for a rooftop greenhouse and recycling center that will turn a ton of food scraps, yard waste, and paper each day into compost to support a lush urban garden.

The $450,000 Urban Rooftop Greenhouse Project, the first of its kind in the United States, will serve as a prototype for thousands of other rooftop greenhouses that one day could handle between 10 and 30 percent of the country's urban solid waste, turning cities into "net exporters of vegetables," says Gaia Institute director Paul Mankiewicz.

Using his own specially formulated lightweight soil, a combination of recycled Styrofoam and organic matter, Mankiewicz will shortly plant his first crop of herbs, exotic salad greens, bulb flowers, and houseplants atop a nineteenth-century Greek revival building in the cathedral complex. The compost collected from the cathedral's school and nearby Columbia University will be stored in hanging bins along the roof's parapet walls so nutrients can drip into an underground feeding system that will nourish the plants. The garden's harvest may be sold through the cathedral shop and to neighborhood stores and restaurants.

THERE ARE MORE THAN 600 ACTIVE VOLCANOES IN THE WORLD; ABOUT 80 OF THEM ARE UNDER THE SEA

High above New York City, a cathedral's garden flourishes.

Rooftop greenhouses can become a multibillion-dollar business capable of revitalizing urban economies, creating jobs for displaced agricultural workers, saving on food-packaging and transport costs, and removing tons of organic material from the solid-waste stream, Mankiewicz says. He estimates that each year a rooftop greenhouse of 8,000 square feet could yield some 40 to 50 pounds of produce per square foot, meeting the needs of one city block of low-rise buildings. Besides the obvious benefits, rooftop greenhouses will also moderate building temperatures and foil burglars by limiting roof access.

"The wealth of an ecosystem is its capacity to turn waste back into resources," Mankiewicz says. "Cities are now taking resources and turning them into waste. What we should like to do is close that circle so that what now becomes pollutants in rivers or heaps in landfills will become part of the urban food web again."

—Mary Ellin Barrett

"Thinking is easy, acting difficult, and to put one's thoughts into action, the most difficult thing in the world."

—Johann von Goethe

HARD TO SWALLOW

Finally, a thermometer that crafty kids can't press against a light bulb to counterfeit a fever. NASA's Goddard Space Flight Center and the Johns Hopkins University Applied Physics Laboratory have developed CorTemp, a thermometer in a pill that monitors a patient's temperature as it travels through the digestive tract.

A silicone capsule the size of a large vitamin pill houses a quartz crystal temperature sensor, battery, and telemetry system that transmit temperature readings to an external monitor. Currently in clinical trials, CorTemp is intended for situations in which a patient's temperature must be observed over an extended time, as in sleep disorders and intensive care. "We're now looking into using the pill to monitor football players who are in danger of heat stress during summer training," says Bill Hicks, president of Human Technologies in St. Petersburg, Florida, which manufactures CorTemp.

Customers have found diverse uses for the device. One company implanted it in giant outdoor video screens, which can overheat in the sun. "One guy," Hicks says, "is even using it to monitor the temperature of beehives."

—Cynthia L. Pollock

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CONTINUUM

A SURPRISE FOR BAMBI

They certainly don't look it, but deer can be dangerous. They harbor ticks carrying Lyme disease, a debilitating illness that attacks humans' central nervous system and internal organs. Now a physician in Armonk, New York, has invented a decidedly low-tech gazebo for white-tailed deer that he thinks can significantly reduce the population of those hazardous ticks.

Kenneth B. Liegner plans to bait his gazebo with a salt lick. When an unsuspecting, tick-laden deer steps on the structure's floor, a weight sensor activates silent hidden pumps, spraying the animal with insecticide from an underground reservoir. Liegner plans to run field tests with cyfluthrin, an insecticide approved by the Environmental Protection Agency that kills the ticks but poses scant danger to the animals that carry them.

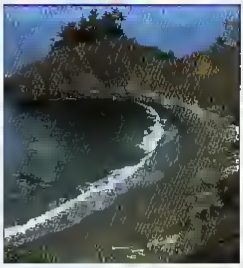
Liegner's invention has a lot going for it, especially in light of the mathematics of Lyme disease. Entomologists have found as many as 500 female *Ixodes dammini* ticks on a single deer, each capable of laying 2,500 to 3,500 eggs, so spraying one animal could prevent 1.5 million eggs from being laid.

After being sprayed, a deer could emerge from the gazebo and collect a new set of ticks, starting the cycle all over again. Liegner admits: "Deer are something like vacuum cleaners for ticks," says the physician, who envisions insecticide-spraying gazebos deployed widely over woodland areas.

—George Nobbe

IN AN ADULT MALE, THE EPIDIDYMIS, THE TUBE THAT CARRIES SPERMATOZOA, IS 15 TO 20 FEET LONG.

PREHISTORIC DRAGONFLIES WERE THE SIZE OF MODERN PIGEONS



The ocean off Oregon's coast hides some new mountains

MOUNTAINS OF THE SEA

A ten-mile chain of small mountains has sprouted since 1981 on the ocean floor about 300 miles off the Oregon coast. Scientists at the Hatfield Marine Science Center in Newport, Oregon, first discovered the fresh pillow lava mounds in 1989 using an underwater camera, and they confirmed the finding in 1990 during dives in the submersible *Alvin* one and a half miles below the ocean surface. When they made the discovery, they were inspecting a submerged mountain chain, called the mid-ocean ridge, that separates the Pacific and Juan de Fuca tectonic plates, which are slowly drifting apart.

The scientists first noticed a difference in the sea floor when they compared soundings and underwater photographs taken in 1989 with a survey map of the sea floor made in 1981. This recent activity indicates that the sea floor spread a few inches since 1981, according to Robert Embley, Chris Fox, and William Chadwick. Fluid lava oozed out from the sea floor, like toothpaste from a tube, forming the new 100-foot-high mounds.

"This is the first documentation of a deep-water eruption on a mid-ocean ridge," Embley says. "Before this, no one had a clue to the volume, the rate of flow, or the time period of these eruptions."

The research team is studying the lava eruptions' relation to megaplumes, huge underwater plumes of mineral-rich water as hot as 700°F. Scientists found megaplumes nearby in 1986 and 1987.

"The sudden input of large plumes associated with sea floor spreading affects the ocean's chemistry," Embley says.—Scott Knap

"Losing the collected wisdom of the rain forest tribes would be like burning every library in the world without bothering to look at what was on the shelves."
—as quoted by Anita Roddick in her book, Body and Soul

Tick, tick, tick, tick. These graceful deer most likely carry dozens of ticks, which can transmit Lyme disease to humans. A specially designed gazebo might help rid deer of ticks—at least temporarily.

CONTINUUM

OUT OF TIME

Want to keep a close eye on how much time your kids spend in front of the television set? Look for a new device called TimeSlot, invented by three North Carolinians

By using what the inventors call an administrator card, which gives access to a control unit attached to the set's power cord, parents can program both the hours in which the television may be turned on and the amount of time their children may watch. Each child gets his or her own bar-coded card, which he or she inserts into the control unit when ready to watch TV. An optical scanner inside the book-sized device reads the card and triggers a clock to start counting down the time allotted the child; it shuts off the set when time runs out.

"We didn't design it as a punitive parent tool," says Leland W. Poole, a founder of Raleigh-based Design Dimension. "We think of it more as a way to help kids manage their time, especially latch-key kids who can become too dependent on TV."

Poole and coinventors Stephen W. Smith and William C. Stewart admit that any reasonably bright child could easily outwit their $129 system. For instance, several kids in a large family could simply agree to watch the same shows, subtracting the time from just one child's card and thus expend their viewing time.

—George Nobbe

DURING A SEVEN-HOUR SLEEP PERIOD, A HEALTHY 25-YEAR-OLD PERSON WAKES TEN TIMES. BY COMPARISON, A HEALTHY SENIOR CITIZEN WAKES AN AVERAGE OF 1.53 TIMES IN THE SAME PERIOD

A ROCK AND A HARD PLACE

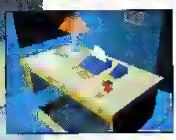
Choosing between helping to overheat the planet or dumping toxic chemicals in waterways and forests wouldn't be pleasant. Some environmental officials, however, have to do just that, now that evidence suggests that efforts to minimize acid rain could unintentionally accelerate global warming.

When sulfur dioxide in the atmosphere transforms to sulfate, acid rain results. Sulfate molecules cluster together in suspended particles called aerosols, which form the nuclei of acidic water drops.

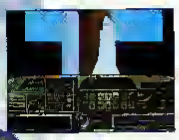
The Environmental Protection Agency has called for dramatic cuts in sulfur dioxide emissions by the year 2000. However, recent satellite data suggest that aerosols, particularly those formed by sulfates, may play a key role in cooling the Earth by reflecting solar radiation that would otherwise reach the surface. These findings may explain why the observed warming of the planet—about 0.5°C over the past century—has fallen short of predictions.

"By clamping down on sulfur-dioxide emissions, we might be removing the brakes on global warming," says Daniel Jacob, a Harvard University atmospheric chemist. "Although acid rain is bad, the alternative may be far worse."—Steve Nadis

Create your own reality.



Build your dream house and design the furniture to put in it. Then, walk around it, fly through it . . . or over it!



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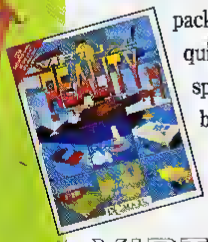

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A nuclear weapons gazetteer for the future, which should be safer but probably is not.

NUCLEAR WORLD ORDER

From Maurizio Zifferero's twenty-eighth-floor office in the Vienna International Centre, the Danube might be a shiny band of gray metal, wandering off toward Germany through green hills and vineyards, bounded by monasteries, ruined castles, and the neat agricultural patchwork of Austria. But the landscape seen most clearly from this high window is less one of brilliant autumn days and ancient rivers than of a world built on the atom—an abstract universe of varying nuclear abilities and aspirations.

From here, Zifferero and other experts at the United Nations' International Atomic Energy Agency (IAEA) observe the nuclear haves and have-nots, the minority of nations lusting to feed at the atomic trough, and the majority that has chosen the path of celibacy, at least where nuclear weapons are concerned. Until now, it has been a world of uncommon order, as dependably immutable as the good manners of Eleanor's medieval court at Aquitaine. The modern knights and heroes had forsworn nuclear weapons, the handful of villains had signaled ambiguity, although some had brazenly galloped off down the atomic trail.

On this day at the end of September 1991, however, that world of easily identified good and bad guys seems as remote, as lost, as twelfth-century chivalry—as distant as the world order that prevailed a year ago. Now, nuclear disarmament is upon us, global tensions have collapsed, and a noble war has been quickly concluded in the Persian Gulf. The music should come up for a happy ending. Instead, one feels something rough and unformed, a beginning, the flickering dawn of an epoch that, in its smaller way, may be worse than what we had before.

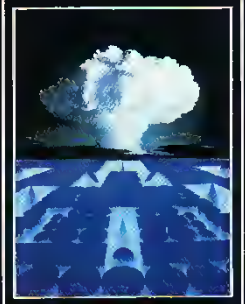
Perhaps Zifferero, the patrician Italian radiochemist across the room, feels this dying of the old nuclear era and broods about the new. But most likely he is concerned entirely with the present. Along with a Daliesque abstract, his walls are hung with low-level aerial photographs of industrial parks, low, faceless buildings scattered upon a pale desert; and flow charts on which nuclear components and uranium converge, as if Zifferero were in the business of manufacturing them. The tables are draped with tactical maps, all crossed by the blue wriggle of another famous river: the Euphrates. That, not the Danube, is the river that bisects the nuclear universe today.

For decades, the world's atomic watchmen have dreamed restively of an omnipresent specter, pervasive but never seen: the Diverter, an individual or nation with the will to siphon uranium or plutonium off to build a secret bomb. This morning, Zifferero, director of the agency's innocuously named Iraq Project, has learned that, by the waters of Babylon, this shadowy figure has finally stepped—or been pushed—into the light. Zifferero's team of 44 inspectors and weapons experts—for the next several days they will be detained by armed troops in an Iraqi parking lot—holds the first tangible proof of a clandestine weapons program. Reams of documents show that Iraq, a nation that had signed the treaty forswearing nuclear weapons, had gone far down the road to its first atomic bomb—and more.

But even were there no proof of a weapons program, his team is anything but business as usual. "We had full access to intelligence information," he says. "Second, we had the possibility to enter whatever site we designated to Iraq. Some difficulties in the beginning, but now the mechanism has been established, they have accepted it." He pauses, thinking perhaps of his 44 detainees. "Finally, the backup of the Security Council. We have a lot of teeth now." Unstated is the fact that the Security Council has also found its fangs in the form of a vast military coalition force poised at Iraq's gates.

In the old days, nobody talked much about teeth. The nations of the world had either codified their good intentions by ratifying or shunning the 1970 Treaty on the Non-Proliferation of Nuclear Weapons—a simple bargain in which the haves agreed to share nuclear technology with the have-nots, who in return swore not to pursue the acquisition of nuclear weapons. Then, to pre-

By Carl A. Posey



Has Bomb:
United States
France
England
China
Commonwealth of Independent States (USSR)
Russia
Ukraine
Belarus
Baltic States
(Estonia, Latvia, Lithuania)

Undeclared weapons states:
India
Israel

Capable:
Canada
Germany
Italy
Sweden
Japan
South Korea
Taiwan
Switzerland
Netherlands
Finland
Belgium

Bombiust: (but not technologically able)
Algeria
Libya
Syria
Iran

Suspected secret bomb programs:
Pakistan
Iraq
North Korea

Believed to have abandoned bomb programs:
South Africa
Brazil
Argentina

clude any sloshing of peaceful knowhow of fissile material into a secret bomb program, the treaty's signatories—many gnawing a sovereign lip at the intrusion—submitted to a system of nuclear safeguard inspections administered by the IAEA. Somewhat diluted by the concessions needed to reach a global consensus, the apparatus was nevertheless given clout—on paper. Inspections could be called without notice in suspicious cases. Violations would be reported to the board of member nations governing the IAEA. Problems that could not be solved there would be sent to the United Nations Security Council. And then the Security Council would . . . well, no one knew what it would do, things had never gotten that far.

Instead, the machinery of verification operated with courtesy, even diffidence, treating saints and suspected sinners equally. In encounters as cordial as those between a venerable firm of auditors and old-money banks, inspectors verified that nations were doing what they said. The uranium in a reactor was of the type and quantity declared, the hot, fissionable contents of spent fuel elements had not been secretly replaced with sand; the material declared to be at a given facility was really there. In the same polite fashion, inspectors visited reprocessing facilities, where plutonium (among other things) is reclaimed from spent uranium, and enrichment facilities where uranium, naturally U-238 flavored with a tiny fraction of fissionable U-235, was rendered more fissile. Throughout, the safeguards system focused on established thresholds called significant quantities—the amount of material that, discovered missing, would indicate a clandestine weapons program. This threshold is set at 25 kilograms of fully enriched—bomb grade—uranium, or eight kilograms of plutonium.

The inspectors followed a narrow mandate. They could look only at what their hosts would show them, they could not roam, nor could they act on their suspicions—there was to be no riding out after outlaws. In such weapons nations as the United States, the United Kingdom, and the Soviet Union, inspectors could visit reactors and other civilian facilities but were not shown weapons-related ones. In such nonsignatories as South Africa and India, inspectors could audit material that, because it originated in a signatory state, came under safeguards—and nothing else. Indian and South African enrichment facilities dropped from the safeguards scope when processing native uranium. Like the ritual wars of New Guinea tribes, such encounters were conducted mainly to show that nobody need get hurt.

Indeed, everyone wore their intentions where they could easily be seen. Three of the nuclear weapons states—the two superpowers and Britain—had signed the nonproliferation treaty. France, entranced with a small but potent *force de frappe*, did not, but par-

CONTINUED ON PAGE 76

COMMONWEALTH ROULETTE

None of the republics that used to be the Soviet Union seems to want to be a nuclear power, even though some have nuclear weapons deployed on their soil. At the same time, no republic has said it is willing for Russia to have the region's only nuclear arsenal. Their agreement to disagree on nuclear arms has produced a fragile, ambiguous apparatus of central control.

At issue are an estimated 27,000 nuclear warheads. Some 12,000 of these are strategic bombs and the warheads for land- and submarine-launched intercontinental ballistic missiles. The rest are the explosive parts of smaller, shorter-range tactical weapons—battlefield nukes.

The pattern of strategic deployment has created a strange and frightening anomaly. Suddenly, the world has four instant de facto nuclear-weapons states—Russia, Belarus, Ukraine, and Kazakhstan—where a few months ago there was only one.

The good news is that most republics lack the technical infrastructure to keep a nuclear arsenal operational. For example, most of the republics do not have the means of keeping the elaborate electronics and volatile chemistries of ballistic-missile systems going. In December, Soviet Major-General Alexander Tsalko told a Brussels security conference that maintenance problems were so severe that it was problematic whether those missiles could be used by anyone. "In the West," said Tsalko, "you are concerned with who has their finger on the button. The greatest issue is not who can push the button but whether it will function at all."

The bad news is that nothing is quite fixed, everything remains fluid, subject to sudden and unforeseeable change, often on the whim of a republic's new leaders. In August 1991, all nuclear weapons were restored to Russia, which stepped into the role formerly played by the Soviet Union. By December, the three nuclear-armed republics had decided not to let their giant sister go it alone, weaponswise. Kazakhstan indicated that it planned to keep its nuclear weapons as long as Russia had its own. Since Kazakhstan hosts the cosmodromes at Tyuratam and Baykonur and the weapons research (Star Wars included) facilities at Shary-Shagan, it certainly possesses the technical means of keeping that arsenal alive.

At a year-end meeting in Minsk, leaders of the 11 republics cobbled into the Commonwealth of Independent States and created a single military command for nuclear weapons—but *only* for nuclear weapons. There was little consensus, however, on exactly where nuclear weapons ended and conventional ones began. To Russia, which wants both possession and control, the term means everything—bombs, aircraft, ships, missiles, the works. To Ukraine, nuclear weapons are nuclear explosives; the army, air force, and navy, they argue, should stay where they are. Despite these quibbles, on Christmas day, outgoing Soviet president Mikhail S. Gorbachev handed over control of all nuclear weapons to Russian president Boris Yeltsin along with the so-called football—a briefcase containing current launching codes. Yeltsin has authority to use the full arsenal, but only in consultation with the leaders of republics where the weapons are deployed.

Meanwhile, in the IAEA, Russia will assume the former Soviet role as a weapons state, pledged to fulfill Soviet obligations under the nonproliferation treaty (NPT). Ukraine and Belarus, both long-time members of the IAEA (and the United Nations), have signaled their intention to join the NPT nations as nonweapons states, as have the three Baltic states. The presumption in Vienna seems to be that all the republics will eventually sign on as nonweapons states as well.

Few think the present controls are as clearly defined as they should be, or afford anything like foolproof weapons control. Former Soviet foreign minister Eduard Shevardnadze, for one, believes the rest of the world should worry. "Go ahead and say," he told an Italian newspaper reporter, "that I would be terrified."

TOURING THE JUNGLE

BY TOM DWORETZKY

I am up to my knees in squishy mud. It gurgles as I lift up my right leg, then it sucks from somewhere in Middle earth and pulls my rubber boot clean off. My left one is buried so solid that I can't hop to regain my balance, I lurch to the side, put my left foot down with an instant sense of doom. It slips down and down and I slap face-first into the muck. I figure at least it's clean dirt.

Welcome to the jungle.

I am a city slicker. Instead of toughing my way past the prostitutes and crack dealers on my block, I must now figure out how to handle leaf-cutter ants the size of cigarette butts whose stings make your arm swell up like a hunk of thigh, and six-foot snakes able to kill oxen with a single bite. Then there are the plants coated with sap nasty enough for chemical warfare that lace you with painful welts when you carelessly brush them.

Takes my mind off other troubles. For half a day now I haven't thought about much besides getting to the Rara Avis Waterfall Lodge in the wilds of northern Costa Rica. Be here now—or wind up like Kurtz (he dead). I have had to slow down and tune into the sounds and sights of the jungle—or get hurt. I'm liberated by the palpable danger of the immediate. I can see now that the jungle is just another bad neighborhood. But since I'm a journalist, you know, danger is my business, I go where the story is, it's my job.

However, I am not exactly working here in the middle of all this tooth and claw. Actually, I am supposed to be on vacation. But you could say that my vacation *is* the story. I'm having a wilderness experience—and paying for it.

This prime example (apposite poge) of a lower montane rain forest in Costa Rico's northwest is home to o vost orray of onimol ond plont life. Becouse the forest is ot o higher elevotion (1,950 meters obove seo level), it's dry, not swompy—o "cloud" forest.

This delicote creature (below left) makes its home in the Mante Verde Cloud Forest Preserve in Casta Rico. Such pratected preserves make up over 12 percent of the tatal oreo of this peaceful, democratic Central Americon country wedged between strife-torn Nicoroguo ond Ponomo.

Though nonvenomous, this rore Costa Ricon snoke, the onnuloted boo (obove middle) con moke plenty of trouble for its prey. It encircles its victims, mostly smoll mommols, then squeezes—forcing the breoth and life out of them.

This orrow-poison frog (obove right) mokes its home in the wilderness of Lo Selvo Biologicol Reseorch Station in Costa Rico. The frog earned its nome from the toxins praduced on its skin. Notives' arrow tips dipped in it ore most deadly.

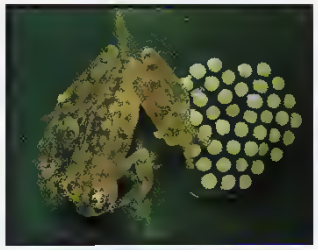
I'm doing what is known as ecotourism, and it might be the best—maybe the last—hope any of us civilized types have to put our dinero where our mouths are and go save a rain forest. It offers a meaningful alternative to a lot of preaching about the environment while the corporations and governments that represent us bottom-line the tropics out of existence by forcing poor campesinos to slash and burn the jungle to pay their country's debts to U.S. banks and raise cattle for fast-food burger chains.

Anyone who's been anywhere in the Third World will tell you that these farmers aren't getting rich destroying their forests—and that they would much rather not ruin them. But some sort of industry has to replace the ones that are now bungling the jungle.

Enter two nondestructive ways to make a bundle in the jungle: ecotourism and a new type of selective farming that harvests plants and animals in the wilderness without destroying the ecosystem in the process.

Amos Bien is one of a new breed of "ecopreneur" practicing these methods. In an effort to make the rain forest pay without destroying it, He founded Rara Avis S.A., a Costa Rican corporation which owns the Rara Avis Waterfall Lodge, a roughhewn mansion-like hotel in the midst of 3,000 acres of unspoiled jungle. He hopes to make Rara Avis a model for such jungle use. When I spoke with Bien in San Jose, he summed up the situation as follows: "What we're up against is that here in Central America people cut down the forest to do subsistence farming—mostly grazing cattle. The net income in Costa Rica for that is between 30 and 40 dollars an acre. It takes about $3,000 a year here to support a family of four. It's not a reasonable way to use this land in terms of the world, but they've got to do it. One reason: You can get bank credit for clearing land because it has a proven earning record even though income production in this way is terrible."

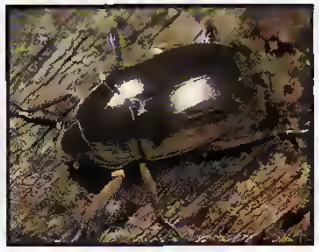
It makes more sense to see if you can produce more



Two rhinoceros beetles (above left), perfect examples of Earth's most profuse insect order, eye each other cautiously—and prudently. Over 250,000 distinct species live around the globe—everywhere except the oceans and near the poles.

The light-green, delicately transparent skin of this glass frog (above right) from Costa Rica provides clear protection from predators. A master of disguise, the frog blends subtly with the jungle's leafy, green foliage. Beside the frog: its next generation of eggs.

Not really lazy, a two-toed sloth (below left) moves mostly at a leisurely pace—upside down. Its point of view may seem a bit odd, but sloths will turn the idea of slothfulness topsy-turvy if aroused. When attacked, they strike back swiftly and powerfully.



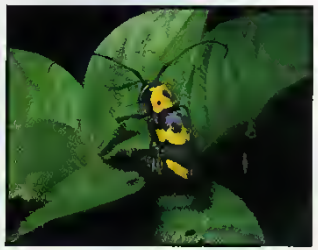
than 30 dollars an acre per year not cutting the forest, which you can do in two ways. First, there's tourism. Bien started with a large piece of forest, but that took a lot of capital and good marketing. It can make a good income but it requires a big, sophisticated investor.

There is another way to use the jungle, though, which Bien hopes to explore while Rara Avis is supported through tourism: selective seeding of commercial plants in the jungle. "The campesinos are land rich, cash poor, and have a labor surplus," he explains. "They have big families and tend to be underemployed. Here we can manage the forest. We can tend individual plants and animals, which is a labor-intensive activity. This is something we don't know precisely how to do yet because each forest has its own distinct and unique products. For example, we discovered on our tract a plant, the dappled palm, previously found only in Panama, that had been harvested to extinction there because of its popularity as an ornamental plant. This palm produces about 100 seeds per year, and there are only 15 of them per hectare. I was offered 15 cents per seed by someone who wanted to set up a nursery, but refused because if we just collected them, they would become extinct in our forest and also would not create work for the local farmers. Instead, we plan to tend them in place, plant more of them in the midst of the jungle, and harvest them selectively. This approach is a model for using the natural resources of the jungle in a way that will leave a diverse forest cover, even though it is no longer virgin. Like the palm, there are other plants that can be tended and judiciously harvested in this way, such as hardwoods, ferns, flowers, and medicinal plants, as well as animals."

The trip to Rara Avis was a real adventure. First stop was Las Horquetas, about an hour north of San Jose, mostly over dirt roads. There, at the house of Roberto Villa Lobos, his wife, and two young children, I and my traveling compadres mounted sturdy little horses equipped with Western saddles

This beetle (opposite page, bottom right) is really a different shade of the pale metals. It's a rare silver lamellicorn found in the Costa Rican rain forests. Its elytra—twin front wings—are waterproof, opaque, and hard. These provide protection from the elements.

Strange insects (below left) look like the best of William Burroughs' and Franz Kafka's worst nightmares. They roost under leaf and lurk underfoot beneath the dense foliage in the rain forest. Wise explorers look carefully before gripping or putting a foot down.



Taking a walk on the wild side (above middle) is made easier at La Selva. The research facility blends the risks of the jungle with the relative safety of a park. Self-guided tours on well-marked and cleared paths permit exploration of undisturbed rain forest.

The beetle (above right) is not only terrestrial—it's everywhere. Different species can be found tunneling deep underground or dwelling in water. While most beetles are plant eaters, some survive by preying on other animals, and others live as parasites.

for the four-hour ride up the mountainous trail. "What about the lack of road signs?" I asked. "Do not worry," Roberto assured us in Spanish. "The horses know the way to El Plastico. From there the four-wheel tractor will take you to Rara Avis."

We rode down the main street, by the Triangle bar and the neat houses painted white with colorful trim, angled left down a fork in the road at the edge of town, and clopped by fields of cows and chicken yards until we reached a swiftly moving stream about 25 yards wide. The shallowest ford still had the water slapping at the bellies of our mounts. We had to balance precariously with legs up by the pommels as the steeds stumbled slowly across the rocky bed.

The road went on and on, as only it can when each mile is measured by a thousand sharp bumps as butt meets a country horse's sharp spine. To either side of the path, the land was cleared. In the distance, occasional clumps of tall rain-forest trees, like spots of hair on a bald man's head, offered their slim refuge to large crows which came to rest after circling in the hot tropic air above pastures sprinkled with small groups of grazing cattle. In the far distance, off to either side of the trail, was the impenetrable curtain of the remaining jungle.

We arrived at the first stop, El Plastico, in time for the midday meal. A ramshackle, one-story sprawl balanced on stilts in the middle of a vast cleared mountainside, it had been a jungle prison colony before Rara Avis began operating it. Some travelers stay at Plastico ($45 per night, including meals). When we signed the guest book, I noticed that Hunter S. Thompson had been here just the month before. "He rode up, looked around, ate, and went back all in the same day," one of our hosts told me. Plastico's first visitor? Noted physicist Murray Gell-Mann.

From Plastico we rode the large open trailer hitched to the back of the four-wheel tractor the remaining two hours to the hotel. The road was a trench of sloppy mud laced

crosswise with logs that crunched and slapped as the wheels pressed onto them. The going was slow and difficult, the tractor seemed to climb wheel over wheel, not roll, as the driver wrestled it up the mountain. Close on either side was the deep jungle. At one point we rounded a bend, and one of the men riding up front on the wheel fenders jumped back casually and started to laugh and point to the bank of the road. Stretched out its full six-foot length was a bushmaster—one of the world's deadliest snakes. The driver stopped while we took pictures of it from the trailer; the snake lay there eying us.

Rara Avis Waterfall Lodge, the hotel, sits at the top of a steep clearing in the midst of dense jungle. It is a two-story structure of roughhewn, unvarnished planks with four double rooms and a large porch on its top floor. The rooms have no glass in their windows, which are permanently screened to keep out all but the smallest bugs. There is hot and cold running water and indoor toilets and showers, but no electricity. There is nothing quite as pleasant as a hot shower—albeit brief, for the water is heated by a small gas affair—after a hard day of travel. But it is odd to bathe by the light of hurricane lamps—the only source of illumination at night. Farther down the slope is a low-slung building that houses kitchen and dining room—open to the elements—and rooms for the small staff.

For the next two days we explored the jungle, helped and protected in this activity by Rara Avis's naturalist guide, Nicholas Clerke—a slight, cheerful, and knowledgeable Englishman.

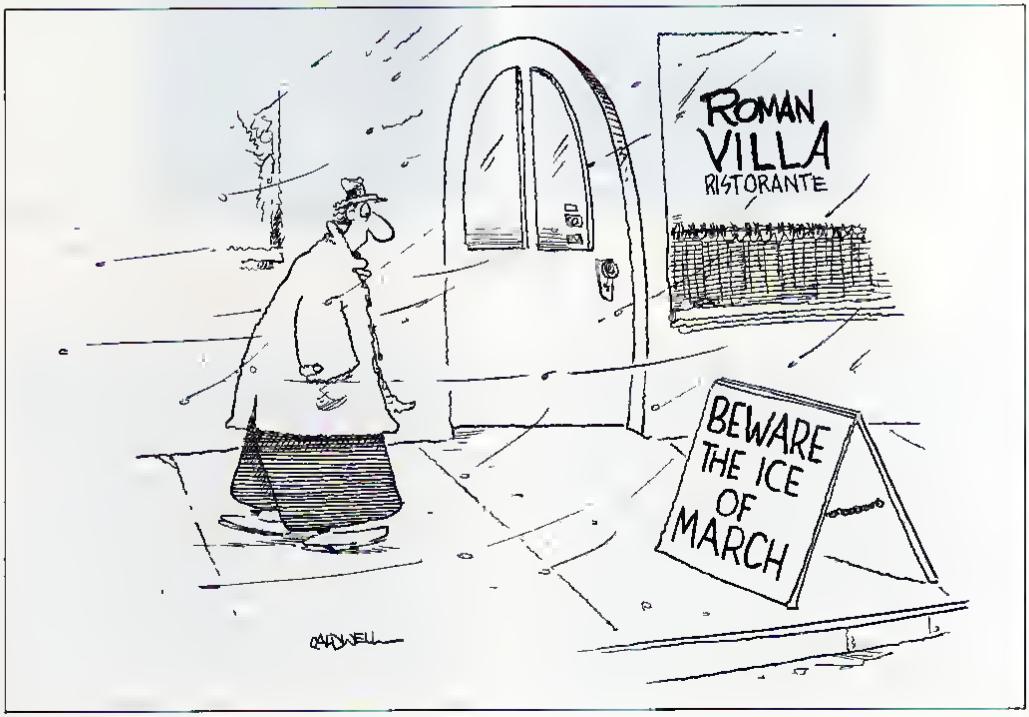
As we climbed through the tunnel-like paths he had mecheted in the dense growth, he showed us animals and plants and explained how they live one off the other, how they wage their struggles for survival in a dense interwoven terrain of harsh combat and chemical warfare.

Surprisingly, the jungle is not quiet at all, but rather raucous and loud with an incessant chatter of leaves and branches banging in the wind, of water dripping, of scurrying sounds in the waist-deep ground cover. The sunlight flickers constantly, too, making deep shadows and burning highlights crop up and disappear with kaleidoscopic uncertainty. It is at first impossible to see or hear anything clearly; it is so disorienting that without Nick in the lead, I would surely have gotten as lost as if I had been on the arid, featureless plain of a vast desert.

The days progress and we continue on exhausting morning and evening hikes that leave me drenched with sweat. He shows us the ways of the jungle: spiders with bodies the size of Ping-Pong balls under broad leaves; millipedes the size of a thumb. High overhead, monkeys chatter (they are very hard to see and fond of peeing down on interlopers). Tropical birds with bright, multicolored beaks slice through openings in the canopy and vanish.

In the midst of perpetual green stillness that forces the heart to pound hypnotically slow a sudden flash of light in the corner of my vision, and there . . . now it's gone. Was that a monkey? A snake? A bird on that branch? That rustle coming out to take the melody from the mesmerizing drumming of clack and rumble—is that a wild pig or a family of pacas (which resemble giant guinea pigs)? Perception becomes a mind game lingering on the border of imagination and reality.

Do I want to see a monkey, or a snake? Then that rustle was one, and there, 50 feet up in the canopy, that dark spot, almost brown—that is a monkey behind a branch. Binoculars may find it, sweat clouding the eyepieces, or may instead find a branch and nothing more. Stay here in the jungle long



enough and Kurtz starts to look like a pretty rational guy.

Before I leave for the tractor-horse express back to Las Horquetas I buy Nick a couple of cold beers (stored in the Waterfall Lodge's gas-powered refrigerator), and we sit under the thatch roof of the dining area, looking out while the anteater crosses the yard between the kitchen house and the main building. We both smell faintly of Avon cologne, reminiscent of a visit to grandmother's for a holiday. (The cologne is very effective at keeping mosquitoes and other bugs away in the jungle—Avon won't officially acknowledge this because then the cologne would have to be approved for use by the FDA, but it's a known fact among veterans of the great outdoors.) About the Rara Avis experiment, Nick says, "For years big organizations like World Wildlife have talked about a new approach to conservation. This is different because we're trying to make a go of it on a commercial level, and that's the only level that a farmer will buy. Subsidizing other ways are suspicious to the farmers because they know that if it's subsidized, then in a few years maybe the program will be canceled. Tourism is one approach, and it's pretty well understood how to make a go of that. But Rara Avis is also a place to do research on how to collect valuable resources from the jungle on a sustainable basis and on how to market them successfully. If we don't want farmers to clear the jungle and grow crops, then we have to develop the technical expertise to grow and harvest plants, like the dappled palm, in the jungle itself."

Rara Avis was the second stop on my ecotour. First I had gone to visit David and Deborah Clark who codirect La Selva Biological Station, an Organization for Tropical Studies (OTS) research station that adjoins Braulio Carrillo National Park, which runs north almost to the Nicaraguan border. Tourists are welcome (for $76 each a night, including a multioccupancy room and three cafeteria-style meals) at the station, a collection of bunk houses and larger low-slung buildings housing labs and a large dining and meeting room.

Wandering the grounds you come across scientists who are absolutely mad about arcane subjects and are usually happy to talk about them if politely asked. A stay in this place reminded me that education is the most profound form of entertainment and that almost nothing in the world is as pleasurable as talking with people who are really enthusiastic about what they do.

The station's two main goals are research and education. To this end, tours of dedicated biology students arrive throughout the season. But La Selva's educational mission is not just aimed at foreigners. "About one-third of our users are Costa Rican natives," says David Clark. Moreover, the station buys everything it can locally—from food to building supplies—and employs local people from nearby Puerto Viejo to cook, clean, build, and act as assistant guides. The latter job requires that they take a course about the area's ecology and history. In addition, the station hosts numerous influential foreign groups, such as members of Congress and their staffs, to educate them on the rain forest issue. Another teaching aim Clark hopes soon to offer courses in preserve management.

The beauty of turning tourism and education into a jungle industry is, says Clark, that there are no negative sides. "Most development projects have negative side effects. The way they are done now. But this way we bring in people and projects that have less impact on the local value system."

Right now tourism is number two on the Costa Rican income list, aided in a big way by the aggressive way in which this tiny country has developed its extensive park system. The central government has set aside a total of about 12 percent of the country's territory for national parks and equivalent reserves. (The U.S. has a bit more than 3.5 percent of its land in a national park system by comparison.) But the park system, only 22 years old, has had to fight to exist—and its strict preserve mentality may be a hindrance as much as a help. Little effort is made to aid tourists to stay in the parks, especially since the park fee is only 70 cents, which must pay for patrolling against poachers and for innovative programs to encourage community involvement, for park rangers, and for education. Thus, the park system gets virtually no money from tourism.

At the same time, Costa Rica is running out of cuttable firewood and needs to plant nearly 15,000 hectares a year starting now. "There is a need to do things and get communities involved and get tourism now," says Clark. "This is the decade when the chicks come home to roost. We [in Costa Rica] have a debt crisis in spades. There's no more land, and the population is rising."

I spent my last night at La Selva, after a fine meal of black beans, rice, porkchops, salad, coffee, and cake for dessert, having fun with a group of biology grad students. We were all quite en-

grossed, sitting on the wide veranda of the main dining building, while one of them, named Margaret, showed everyone the botfly she had allowed to gestate for three weeks—under the scalp, just by the part of her long, blond hair. "It only hurts when it moves around—about once every 12 hours." She had let it go all this long so she could study it, she told me. That night, after we spoke, some gasoline finally drove the little bot from her top. When I left the next morning, I asked her how her mother would have felt about what she had done. 'Oh fine," she laughed, "She's a tropical biologist, too."

Crazy. But if you want a vacation that is active and a real adventure and at the same time lets your money work directly to save the rain forests, take a spin through Rara Avis or La Selva. (There are, of course, other such spots around the world.) As Amos Bien told me, "It's the real thing, being out here, not Disneyland. You're in the jungle and not on some ride. The experience isn't watered down—except that at Rara Avis, you have good beds and great food."

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CRUMBLING INFOSTRUCTURES

ARTICLE BY GREGG KEIZER

A fire storm's brewing in the soul of the Information Age. Millions of books and images and billions of bytes are at risk. It's as if a copy of the ancient Library of Alexandria went up in smoke every day.

Preserving our informational past and retaining the day-to-day bits and pieces that keep our world working isn't easy. The volume of new information added each year is staggering. At the same time, old movies and new books crumble, while magnetic tape and compact discs deteriorate.

In a quest to put out the fire—the problem of book and paper decay is often called the *slow fire*—librarians, film curators, archivists and data collectors look for new technologies to save what we already have and ensure the longevity of what we create. Cautious by virtue of their mission—they want tools that protect our material heritage for centuries, not merely decades—the preservationists are turning to proven processes while waiting for breakthroughs in everything from computers to chemicals.

WHAT'S MISSING. "Our whole cultural heritage is in danger," says Ken Harris, director for preservation at the Library of Congress. "Anything recorded on paper is in danger of being lost."

Since the mid 1800's, when paper makers began coating their stock with aluminum sulfate for crisper printing, books have literally crumbled into dust. Reacting with moisture, these chemicals create sulfuric acid, which devours the paper's molecular bonds over time. In the Library of Congress alone, 70,000 volumes are shifted in classification from weak to brittle each year, becoming too delicate to use without risking damage. Worldwide, libraries hold a billion crumbling books. "The global progression [of disintegrating books] is alarming," Harris says.

Motion pictures, the twentieth century's art form, are in even greater peril. "It's already happened," says Gregory Lukow, deputy director of the National Center for Film and Video Preservation at the American Film Institute in Los Angeles. "Of the 21,000 feature films made before 1950, half don't exist anymore." He ticks off the other casualties: half of the television made in its Golden Age, 80 percent of the movies from the 1920's, 95 percent of the films made in the teens. All gone.

Decay claims films as well as books. Until 1951 movies were shot on nitrate stock, a flammable celluloid that virtually eats itself. Color movies made from the mid 1950s to the early 1980s quickly fade to a pale magenta. "It's beyond danger," says Lukow. "We're just trying to halt the ongoing crisis."

Higher up the technological ladder things aren't any safer. Computer data, once thought inviolate, turns out to be ephemeral instead. "You're always in danger," says Ken Thibodeau, director of the Center for Electronic Records at the National Archives in Washington, D.C. "Magnetic tape is very fragile—you can wipe it out any number of ways. I've heard from people who say they lose as much as 15 percent of their data annually." But the Big Bang of information made possible by computers isn't in jeopardy simply because of defective tape. Unlike books, computer technology changes, sometimes dramatically, always rapidly. With each leap in the underlying technology, old formats are abandoned. Unless data is copied at each format change, it's quickly irretrievable—the machines to read that information cease to exist.

Everyone struggles against the ticking of the clock. "Right now, we're just buying time," sighs Gregory Lukow.

THE PAPER CHASE. It's ironic that newer books fall apart while centuries-old manuscripts remain intact. Acidic paper's the problem, but the solution is less clear.

Coat paper with an airtight barrier, and you can stop any decay. That's the tack Nova Tran, a Wisconsin-based manufacturing company, takes with parylyne, an inert polymer developed 35 years ago as a covering for such things as pacemakers and now used to harden parts for NASA's Shuttle. "It's not unlike molecular glue," says Bruce Humphrey, a conservation specialist with the company. Parylyne can be spread in layers as thin as 12 to 30 microns—layers so fine that it's undetectable even to the touch.

ILLUSTRATION BY CLAYTON ANDERSON

Applied to everything from 2,500-year-old Egyptian mummy hands at the Royal Ontario museum to costumes at DisneyWorld, parylyne has coated documents ranging from nineteenth-century court records to fire-damaged books from the Soviet Academy of Sciences. It lasts virtually forever, "thousands of years under museum conditions," according to Humphrey. That's both a boon and a bane. Once slapped on it cannot be removed. "It literally grows on surfaces, surrounds the individual cellulose fibers," Humphrey says. The Library of Congress is looking at parylyne as one high-tech, and high-priced, way to preserve paper.

But with costs of $300 a book, parylyne won't solve the brittle-book problem. Institutions like the Library of Congress must find a more affordable way to preserve vast numbers of volumes.

Mass deacidification is one way to scale up preservation. The Library of Congress is in the final stages of a decade-and-a-half search for a feasible chemical process that can handle huge numbers of books. "We're taking an assertive approach [on mass deacidification]," Ken Harris says.

One notable technology pumps diethylzinc (DEZ) gas into a chamber containing the item to be preserved. The gas neutralizes the acid in the paper, stops the rot, and protects the paper from further damage. A pilot plant in Texas can treat up to 40,000 books a year. Theoretically a working facility could process half a million books a year for as little as $6–$10 a book.

Another way to beat the acid problem is to simply do away with paper. "If we have a vision, the vision should be one of a method of mass transformation of information to digital form," says Carl Fleischauer, coordinator of the Library of Congress's American Memory project, an attempt to put everything from the eighteenth-century Congressional documents to thousands of Civil War photographs on optical discs. Text and photographs are digitized, placed on magnetic tape or on an optical disc, and then read or viewed with a computer. Present optical-disc technology, with plastic platters, isn't stable enough for archivists, but Chandru Shahani, a preservation research officer with the Library, is confident that things will improve, perhaps using glass or metallic discs. "The longevity can come," he says. "It may or may not be here today, but we can develop a stable optical disc. A lot of groundwork needs to be done, but it's one of the hopes of the future."

But it's unlikely that the future will be completely paperless. "Traditional objects, like books, will be around in significant quantities for our grandchildren," says Harris. "Certainly there will be a lot more electronic information, but I can't imagine libraries without walls in the next decade or two."

NITRATE NIGHTMARES. "In many ways, films are the most fragile of media," says Gregory Lukow of AFI. "You can make film last longer by storing it properly, but it begins to deteriorate the moment it comes out of the lab."

The most common way to preserve older films is to transfer them to slow-fading, nonnitrate stock and then store them in climate-controlled environments. But this low-tech technique is both costly and time-consuming. Moving a color movie to safety stock costs anywhere from $50,000 to $100,000, and if the film needs to be restored or repaired before it's transferred, the price tag can top half a million dollars. Keeping prints and negatives in air-conditioned vaults is beyond the capability of most public archives.

Some studios, however, have invested millions to safe-keep their prized possessions. Paramount, for instance, stores its films in a 40,000-square-foot archive building on its lot and in a con-

verted Pennsylvania limestone mine.

Preserving television and video is even tougher. Videotape shows wear after five years, sometimes less. And with over 100 different video formats in the last 30 years, equipment obsolescence is a real problem. "When you talk about film, you talk about restoring film. With video, what you have to restore is the equipment," Lukow says.

Digital images, especially high-definition digital images, may be one possible future for moving pictures. Using sophisticated computers, films could be scanned, electronically repaired or reconstructed, and then saved to some sort of digital storage media. Turning film into bits and bytes sounds like a good idea—reproductions, no matter how far removed from the original, are identical to the original. Yet today's digital technology has limits, not the least of which is its poor resolution when compared to film. But torn between a choice of HDTV-style (high-definition television-style) reproductions and no film at all, preservationists may pick the latter.

At the Microelectronics and Computer Technology Corporation, a consortium funded by most of the computer industry's major players, work is progressing on a holographic memory technology that may be the answer by 1995. Two laser lights shine into a photorefractive crystal to create a three-dimensional pattern of light and dark areas, analogous to the 1s and 0s that represent data on a computer disk. A single laser light "reads" those patterns to retrieve the digital information at an astounding speed. A crystal no larger than a fingernail can hold the equivalent of thousands of books.

"We have designs that can hold a full-length movie in high-definition format," says Stephen Redfield, director of Optics and Computing at the Austin, Texas-based corporation. "A removable cartridge no bigger than your palm can contain an entire motion picture."

Holographic memory's speed is one of its best cards. "It's a thousand times or more faster than a disk," says Redfield, because it has no moving parts and it moves data as images, unlike magnetic media. But until holographic memory proves its longevity, preservationists may be stuck with film. "The crystals are kind of a designer material in that we can change their chemical composition, but whether or not we can design one that will last a century, we don't know," says Redfield.

"In the year 2000, we will still be working on preserving our film heritage," Lukow says. "There will still be color fading to stop, there will still be lots of video formats to deal with, to juggle and monitor and transfer to whatever is state of the art at the time. We'll still be buying time."

THE VANISHING BITS. Computers run the world. They track financial transactions involving billions of dollars, certify our existence with the government, and store the minutia of the past in thousands of feet of magnetic tape.

They can also lose information.

Tapes of the 1960 U.S. Census became obsolete shortly after their creation, and for years the data was incognito—there are only two machines in the world that can read the original tapes, and one of them is in the Smithsonian. Fortunately, the records were eventually reclaimed and restored to a more modern format.

"You have a dual problem with computer data," says Ken Thibodeau of the National Archives. The media is not only much more fragile, but technological changes often give you problems within three to five years."

There's no simple solution to magnetic media's life span and no solution at all to the quick turnover in hardware. "There's nothing on the market now that I would call an alternative media," Thibodeau says. "What we will probably move to is called square tape. It stores five times the characters per inch as reel-to-reel tape, it's still magnetic, and we know it's reliable. There's higher-density stuff, but it's not stable. We wouldn't consider CD-ROM, for instance, because it's just not durable." Citing examples of oxidizing platters and data loss within three to four months, Thibodeau admits that larger-format optical discs may last as long as a century. "But there might not be a drive to read the information in a hundred years."

In South Dakota, at the EROS (Earth Resources Observing Systems) Data Center, as much as 90 percent of the data obtained from Landsat earth observation satellites before 1979 is inaccessible because the computers and tape drives have long since hit the junk pile. And officials at the Center are anxious about the future, considering NASA's planned EOS (Earth Observing System) satellites scheduled to fly later in the decade. Data will literally pour down the gravity well from the EOS platforms to the tune of an estimated trillion bytes of data every few days. "It just stretches my imagination," says Ron Parsons, acting chief of computer services.

Computer archivists like Ken Thibodeau are putting their trust in technologies that haven't even made it out of the labs yet. "My real hope for the future is that there will be a solid-state media. It's basically a block of crystal able to store a terrabyte (a trillion bytes, or characters) of information. That's equal to about 100,000 reels of today's magnetic tape. You structure the crystal to store the data and only need to send currents along those crystals. There's nothing that moves."

MCC's Holostore may be another way to compactly and reliably preserve vast amounts of computer data. "You're looking at hundreds of gigabytes in some of these configurations," says MCC's Stephen Redfield. "Holostore is as generic as magnetic storage and can encompass a variety of different media" all of which may prove to be easier to maintain for longer periods than computer tape or disks.

Whether electronic information moves away from magnetic media is less important than what we'll be able to do with it, according to Ken Thibodeau. "Within ten years, we'll have a way to pull out specific data for what ever purpose from any file, at least for data that currently exists. We'll be able to send that data over a network to link up with major educational and research settings. You may have to access it through an information broker, but that broker might be your local library.

BANK THE FIRES. If information is our lifeblood, then we've bled fer too long. Not only have we already lost huge tracts of our cultural heritage, but there's little chance we can save all we have now. "We're forced to make trade-offs every day," notes Greg Lukow. Lack of money and lack of time guarantee that some of what we have today will be gone tomorrow.

Promising technologies, especially those that depend on computers and digital forms of information, hold out some hope. But the technologies play second to simple preservation. "I worry that the production of new electronic information has outplaced the ability of institutions to properly archive it and provide access to it," says Carl Fleischauer of the American Memory project. "So let's focus on how a society maintains information. We have to have confidence in the administration of information rather than worry about the way it's stored."

ROBERT BAKKER

The hot-blooded paleontologist who revolutionized our vision of dinosaurs offers up some more "heresies" about daily life in the Jurassic

PHOTOGRAPHS BY ALAN LEVENSON

TITLE:
Adjunct Curator, University of Colorado Museum, Boulder

BOOK WRITTEN:
The Dinosaur Heresies (1986)

QUOTE:
"If you could mechanically hybridize an ostrich with a rhino, you'd have a quadrupedal dinosaur."

WHAT PALEONTOLOGY NEEDS:
More amateurs

The man who made dinosaurs successful has taken time off from his PR campaign for the 215-million-year-old monsters to spend "quality time with the rocks." The particular rocks that have lured the controversial paleontologist, Robert Bakker, from the TV talk-show circuit, consultations with museum curators, writing books, and designing robot dinosaurs, are those of the Morrison Formation on the Colorado Front Range. Armed with the usual tools of his trade—chisel, thin glue, and plaster—and the not-so-usual *Omni* reporter, Bakker chips away at what was once a dry flood plain and is now a crumbly ledge of alkaline mudstone. He is extracting the cervical vertebra of a giant sauropod from "a strange death scene. The animal might have died a couple hundred yards that way, been chewed up, and then the next flood washed the bones over here," Bakker speculates.

The Morrison, fossil territory that marks the Jurassic-Cretaceous boundary line around 140 million years ago, is the paleodetective's favorite formation. "Maybe because one of my first bits of dinosaur heresy was to prove the Morrison fauna was a dry-land fauna. That *Brontosaurus* didn't live in the swamps!" exclaims Bakker in his booming voice. Much later Bakker admires the sculptural "gizmos, geegaws, and chatchkas" of the giant vertebra displayed on his kitchen table. "Is this a beautiful object or what?" he asks rhetorically. "Now I have to study this fossil, describe it, diagram it, and publish it, so that other people can understand it. It's like . . . God has given me this vertebra, and I'm responsible for its future now."

Bakker's Divine Mission to reveal the truth about dinosaurs was inspired by a 1955 *Life* magazine article, "The World We Live In," which ironically depicted a traditional green brontosaur slogging through swamps. In a moment he now describes as "Saul's conversion on the road to Damascus," the New Jersey ten-year-old resolved to devote his life to the extinct vertebrates. At the time, dinosaurs were sorely neglected by serious scientists because, according to Bakker, "They were evolutionary flops. Everything about them was already known, they were slow, aquatic reptiles of interest only to second graders."

As a Yale student Bakker spent nights rummaging through the drawers of the university's fossil collection, studying the configuration of dinosaur bones. One evening, as he stared at the centrosaur in the Peabody Museum, mounted so that its rear legs stood upright like an elephant's and front legs sprawled like a lizard's, he realized the mount was wrong. The bone and joint structure of a centrosaur's front end didn't spell *sprawl*. This revelation raised his growing suspicion that dinosaurs were not very lizardlike at all.

In his first paper, 23-year-old Bakker posed a question that was to bring a dormant dinosaur paleontology back to life: "If dinosaurs were really slow-moving mountains of cold-blooded flesh, how did they manage to suppress speedy, warm-blooded mammals for millions of years?" He illustrated his radical new vision with illustrations of the ancient behemoths thundering along at 40 miles per hour. Colleagues replied with skeptical "harrumphs." Bakker responded by growing his hair into the ponytail he has never cut, tossing his tie in the trash, and going public with his prodinosaur theories.

In a 1975 *Scientific American* article, he proclaimed, "Evidence suggests that dinosaurs never died out completely. One group still lives. We call them birds!" In opposition to conventional dogma, he declared dinosaurs to be warm-blooded, energetic creatures who regulated their own temperatures. As evidence he invoked the widespread locale of fossils in chilly as well as semitropical environments, the microstructure of dinosaur bones, and the strength and size of dinosaur limbs. Tricera-

> "Anyone who understands the front end of a Chevy Suburban can understand how a dinosaur is put together if you tell him without jargon."

tops, he showed possessed the biomechanical machinery to gallop as fast as the modern rhino.

Throughout the next decade, Bakker extended his unorthodox ideas by studying metabolic rates of crocodiles. Fieldwork in Utah's Dinosaur Monument and research while a professor at Johns Hopkins provided him with important clues about how dinosaurs, and the plants they ate, evolved. In 15 expeditions, Bakker named two species of Jurassic dinosaurs and 11 species of early mammals. His sharp eyes also detected new dinosaurs among mislabeled museum fossils.

Before these paleontology-shaking discoveries, however, Bakker had already shocked colleagues with a controversial book, *The Dinosaur Heresies*, illustrated with warm-blooded creatures lunging and bellowing, charging and courting. In a burgeoning Mesozoic market jammed with dinosaur boo-boo strips, triceratops-shaped cereal, dino-egg soap, and inflatable plastic Stegosaurs, the book became a bestseller. Academic critics howled. Although professionals continue to protest his glib promotion of unproved theories, Bakker remains a favorite with extinct vertebrate fans. As consultant to Dinamation, a California company producing exhibits of robotic dinosaurs, and a lecturer who commands thousands of dollars a pop, he is impervious to peer review, or "smear review," as he terms negative critiques.

When *Omni* interviewer Vicki Lindner first encountered Bakker, he snatched away the "script," as he called a list of carefully researched questions he'd answered dozens of times before, and dazzled her with a monologue on dinosaur science while sketching a muscle attachment to a sauropod spine and throwing balls for his dog. "You've got to come up with a new angle," he told Lindner. "How about Are dinosaurs kosher?" Actually, the former street evangelist explained, "The law of Moses forbid the eating of reptiles because they crawled on their bellies. Maybe dinosaurology fell into such doldrums because dinosaurs weren't kosher."

Omni: You are the self-proclaimed *enfant terrible* of dinosaurology. What in your background enabled you to take an adversarial position?

SOME RECENT FINDS:
Zofiabaatar
("Mutant Ninja Chipmunk"),
Foxraptor
(tiny mammalian meat-eater),
Uluops
(neurologically advanced turtle),
Drinker
(tiny dino)

FAVORITE DINOSAUR:
The one I'm digging up at the time.
I really get into that one.

ALL TIME FAVORITE:
Ceratosaurus.
But I don't know why.

DINOSAUR HOT SPOT:
China.
It's an interesting piece of real estate because it has many habitats, basins.

Bakker: Peering into peoples' psyches is rude! I mean, it's not what you do in a cowboy bar—"Howdy, stranger, can I peer into your psyche?" You'd get punched out. But, anyway, here's a hypothesis, probably bogus, but a lot of fun. My maternal grandmother was from Friesland, the part of Holland where freethinkers, antipapists, Jews, smugglers and counterfeiters went and were hanged as criminals. The family agreed she was a little loony but interesting. And more than once it's been said I take after Grandma Meyer. I don't back down.

Hey, you're supposed to ask, Why did you get married four times?

Omni: I was saving that question until we got to know each other better.

Bakker: Very simple. I needed the blenders. If you want a Cuisinart, a microwave or a really good blender, you get married. These things cascade upon you. I've had some wonderful weddings. The first time I got married, it was the weekend we closed Yale down during the Bobby Seale trial. We couldn't get into the courthouse to get the license because guys with machine guns wouldn't let us in.

Omni: Does it take special instincts or scientific techniques to find important new fossils?

Bakker: Technique schmechnique! The most important technique is picking up a fossil and looking at it carefully. Some can see shapes and others can't. It's not instinct; it's learning. That's why Jack Horner, curator of Paleontology at the Museum of the Rockies, Bozeman, Montana, found the maiasaur nests in Montana, and Ivy League professors of four generations who went near that area did not. They didn't have the field smarts to read the rocks, to know what type of fossils occur in what color and texture of rock. You go over the documents again and again until you see the patterns. Sometimes you can explain what you find, sometimes you can't. Freaky things happen.

Once my whole crew was digging at a huge quarry where we knew there had to be fossils. Dig, dig, dig, nobody found anything. I'd come by and look on the ground and there'd be a complete jaw, another, and another. They thought I belonged to a secret religion! Another time my wife Constance and I were out in the Wyoming Big Horns

CONTINUED ON PAGE 90

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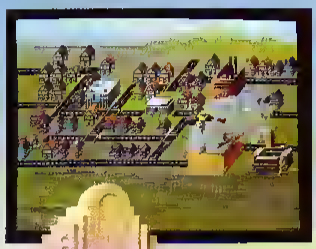

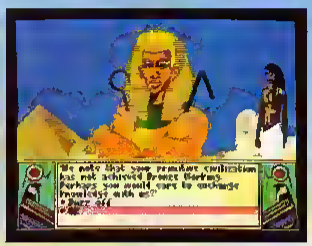

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"Dead Men Cant Play Jazz."

"That's the truth I learned last night at the world premiere performance of the quartet known as Afterlife at Manhattan's Village Vanguard.

"Whether or not they can play, period, that's another matter, but it wasn't jazz I heard at the Vanguard, it was something bluer and colder, something with notes made from centuries-old Arctic ice and stones that never saw the light of day, something uncoiling after a long black sleep and tasting dirt in its mouth, something that wasn't the product of creative impulse but of need.

A LITTLE NIGHT MUSIC

Fiction By Lucius Shepard

Illustrations By Daniel Adel

"But the bottom line is, it was worth hearing

As to the morality involved, well, I'll leave that up to you, because that's the real bottom line, isn't it, music lovers? Do you like it enough and will you pay enough to keep the question of morality a hot topic on the Donahue show and out of the courts? Those of you who listened to the simulcast over WBAI have probably already formulated an opinion The rest of you will have to wait for the CD

"I won't waste your time by talking about the technology If you don't understand it by now, after all the television specials and the (ohmygodpleasenotanother) in-depth discussions between your local blow-dried news creep and their pet science-fiction hack, you must not want to understand it Nor am I going to wax profound and speculate on just how much of a man is left after reanimation The only ones who know that aren't able to tell us, because it seems the speech center just doesn't thrive on narcosis Nor does any fraction of sensibility that cares to communicate itself in fact, very little seems to thrive on narcosis aside from the desire . . no like I said, the *need* to play music

"And for reasons that God or someone only knows, the *ability* to play music where none existed before

That may be hard to swallow, I realize, but I'm here to tell you, no matter how weird it sounds it appears to be true

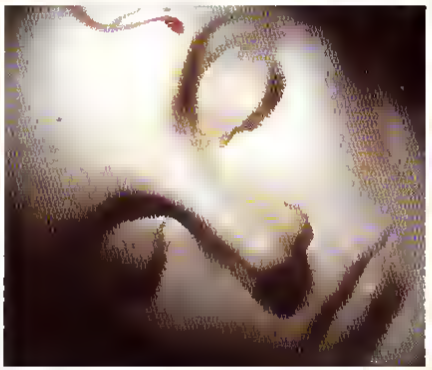
"For the first time in memory, there was a curtain across the Vanguard's stage I suppose there's some awkwardness involved in bringing the musicians out Before the curtain was opened William Dexter, the genius behind this whole deal, a little bald man with a hearing aid in each ear and the affable simple face of someone who kids call by his first name, came out and said a few words about the need for drastic solutions to the problems of war and pollution, for a redefinition of our goals and values Things could not go on as they had been The words seemed somewhat out of context, though they're always nice to hear Finally he introduced the quartet As introductions go, this was a telegram

" 'The music you're about to hear' William Dexter said flatly, without the least hint of hype or hyperventilation, 'is going to change your lives'

"And there they were

"Right on the same stage where Coltrane turned a love supreme into song, where Miles singed us with the hateful beauty of needles and knives and Watts on fire, where Mingus went crazy in 7/4 time where Ornette made Kansas City R&B into the art of noise, and a thousand lesser geniuses dreamed and almost died and were changed before our eyes from men into moments so powerful that guys like me can make a living writing about them for people like you who just want to hear that what they felt when they were listening was real

Two white men one black, one Hispanic the racial quota of an all-American TV show, marooned on a radiant island painted by a blue-white spot. All wearing sunglasses



"Raybans, I think

"Wonder if they'll get a commercial

The piano player was young and skinny, just a kid, with the long brown hair of a rock star and sunglasses that held gleams as shiny and cold as the black surface of his Baldwin The Hispanic guy on bass couldn't have been more than eighteen, and the horn player, the black man, he was about twenty-five, the oldest. The drummer, a shadow with a crew cut and a pale brow, I couldn't see him clearly but I could tell he was young too

"Too young, you'd think, to have much to say

"But then maybe time goes by more slowly and wisdom accretes with every measure in the afterlife

"No apparent signal passed between them, yet as one they began to play "

Goodrick reached for his tape recorder, thinking he should listen to the set again before getting into the music, but then he realized that another listen was unnecessary—he could still hear every blessed note The ocean of dark chords on the piano opening over a snaky slithering hiss of cymbals and a cluttered rumble plucked from the double bass, and then that sinuous alto line, like snake-charmer music rising out of a storm of thunderheads and scuttling claws, all fusing into a signature as plaintive and familiar and elusive as a muezzin's call Christ, it stuck with you like a jingle for Burger King though nothing about it was simple It seemed to have the freedom of jazz, yet at the same time it had the feel of heavy ritual music

Weird, shit

And it sure as hell stuck with you

He got up from the desk, grabbed his drink and walked over to the window The nearby buildings ordered the black sky, ranks of tombstones inscribed with a writing of rectangular stars, geometric constellations, and linear rivers of light below flowing along consecutive chasms through the high country of Manhattan Usually the view soothed him and turned his thoughts to pleasurable agendas as if height itself were a form of assurance an emblematic potency that freed you from anxiety But tonight he remained unaffected The sky and the city seemed to have lost their scope and grandeur, to have become merely an adjunct to his living room

He cast about the apartment, looking for the clock. Couldn't locate it for a second among a chaos of sticks of gleaming chrome, shining black floors, framed prints, and the black plush coffins of the sofas He'd never put it together before, but the place looked like a cross between a Nautilus gym and a goddamn mortuary Rachel's taste could use a little modification

Two-thirty a m Damn!

Where the hell was she?

She usually gave him time alone after a show to write his column Went and had a drink with friends

Three hours, though

Maybe she'd found a special friend Maybe that was the reason she had missed the show tonight If that was the case, she'd been with the bastard for what? Al-

most seven hours now Screwing her brains out in some midtown hotel

Bitch! He'd settle her hash when she got home

Whoa, big fella, he said to himself Get real. Rachel would be much cooler than that . . make that *had been* much cooler Her affairs were state of the art, so quietly and elegantly handled that he had been able to perfect denial This wasn't her style And even if she were to throw it in his face, he wouldn't do a thing to her Oh, he'd want to, he'd want to bash her goddamned head in But he would just sit there and smile and buy her bullshit explanation

Love, he guessed you'd call it, the kind of love that will accept any insult, any injury though it might be more accurate to call it pussywhipped There were times he didn't think he could take it anymore times—like now—when his head felt full of lightning, on the verge of exploding and setting everything around him on fire But he always managed to contain his anger and swallow his pride, to grin and bear it, to settle for the specious currency of her lovemaking, the price she paid to live high and do what she wanted

Jesus, he felt strange Too many pops at the Vanguard. that was likely the problem But maybe he was coming down with something

He laughed

Like maybe middle age? Like the married-to-a chick-fifteen-years-younger-paranoid flu?

Still, he had felt better in his time. No real symptoms just out of sorts, sluggish, dulled, some trouble concentrating.

Finish the column, he said to himself just finish the damn thing, take two aspirin, and fall out Deal with Rachel in the morning

Right

Deal with her

Bring her breakfast in bed, ask how she was feeling, and what was she doing later?

God, he loved her!

Loves her not Loves Loves her not

He tore off a last mental petal and tossed the stem away Then he returned to the desk and typed a few lines about the music onto the computer and sat considering the screen After a moment he began to type again,

"Plenty of blind men have played the Vanguard, and plenty of men have played there who've had other reasons to hide their eyes, working behind some miracle of modern chemistry that made them sensitive to light. I've never wanted to see their eyes—the fact that they were hidden told me all I need to know about them But tonight I wanted to see. I wanted to know what the quartet was seeing, what lay behind those sunglasses starred from the white spot Shadows, it's said But what sort of shadows? Shades of gray, like dogs see? Are we shadows to them, or do they see shadows where we see none? I thought if I could look into their eyes I'd understand what caused the alto to sound like a reedy alarm being given against a crawl of background radiation, why one moment it conjured images of static red flashes amid black mountains moving, and the next brought to mind a livid blue streak pulsing in a serene darkness, a mineral moon in a granite sky

"Despite the compelling quality of the music I couldn't set aside my curiosity and simply listen What was I listening to, after all? A clever parlor trick? Sleight of hand on a metaphysical level? Were these guys really playing Death's Top Forty, or had Mr William Dexter managed to chump the whole world and program four stiffs to make certain muscular reactions to subliminal stimuli?"

The funny thing was, Goodrick thought, now he couldn't stop listening to the damn music In fact, certain phrases were becoming so insistent, circling round and round inside his head, he was having difficulty thinking rationally

He switched the radio on, wanting to hear something else, to get a perspective on the column

No chance

Afterlife was playing on the radio, too

He was stunned imagining some bizarre *Twilight Zone* circumstance, but then realized that the radio was tuned to WBAI They must be replaying the simulcast. Pretty unusual for them to devote so much air to one story Still, it wasn't everyday the dead came back to life and played song stylings for your listening pleasure

He recognized the passage They must have just started the replay Shit, the boys hadn't even gotten warmed up yet

Heh, heh

He followed the serpentine track of the alto cutting across the rumble and clutter of the chords and fills behind it a bright ribbon of sound etched through thunder and power and darkness

A moment later he looked at the clock and was startled to discover that the moment had lasted twenty minutes

Well, so he was a little spaced, so what? He was entitled He'd had a hard wife life Wife The knifing word he'd wed, the dull flesh, the syrupy blood, the pouty breasts, the painted face he'd thought was pretty The dead music woman, the woman whose voice caused cancer, whose kisses left damp mildewed stains, whose

His heart beat flabbily, his hands were cramped, his fingertips were numb and his thoughts were a whining, glowing crack opening in a smoky sky like slow lightning. Feeling a dark red emotion too contemplative to be anger, he typed a single paragraph and then stopped to read what he had written

"The thing about this music is, it just feels right. It's not art, it's not beauty, it's a meter reading on the state of the soul, of the world It's the bottom line of all time, a registering of creepy fundamentals, the rendering into music of the crummiest truth. the statement of some meager final tolerance a universal alpha wave, God's EKG, the least possible music the absolute minimum of sound, all that's left to say, to be, for them, for us maybe that's why it feels so damn right. It creates an option to suicide, a place where there is no great trouble only a trickle of blood through stony flesh and the crackle of a base electric message across the brain."

Well, he thought. now there's a waste of a paragraph. Put that into the column, and he'd be looking for work with a weekly shopping guide.

He essayed a laugh and produced a gulping noise. Damn, he felt lousy.

Not lousy, really, just . . . just sort of nothing. Like there was nothing in his head except the music. Music and black dead air. Dead life.

Dead love. He typed a few more lines.

"Maybe Dexter was right, maybe this music *will* change your life. It sure as hell seems to have changed mine. I feel like shit, my lady's out with some dirtball lowlife and all I can muster by way of a reaction is mild pique. I mean, maybe the effect of Afterlife's music is to reduce the emotional volatility of our kind, to diminish us to the level of the stiffs who play it. That might explain Dexter's peace-and-love rap. People who feel like I do wouldn't have the energy for war, for polluting, for much of anything. They'd probably sit around most of the time, trying to think something, hoping for food to walk in the door . . ."

Jesus, what if the music actually did buzz you like that? Tripped some chemical switch and slowly shut you down, brain cell by brain cell, until you were about three degrees below normal and as lively as a hibernating bear. What if that were true, and right this second it was being broadcast all over hell on WBAI? This is crazy, man, he told himself, this is truly whacko.

But what if Dexter's hearing aids had been ear plugs, what if the son of a bitch hadn't listened to the music himself? What if he knew how the music would affect the audience, what if he was after turning half of everybody into zombies all in the name of a better world? And what would be so wrong with that?

Not a thing. Cleaner air, less war, more food to go around . . . just stack the dim bulbs in warehouses and let them vegetate, while everyone else cleaned up the mess.

Not a thing wrong with it . . . as long as you weren't in the half that had listened to the music.

The light was beginning to hurt his eyes. He switched off the lamp and sat in the darkness, staring at the glowing screen. He glanced out the window. Since last he'd looked, it appeared that about three-quarters of the lights in the adjoining buildings had been darkened, making it appear that the remaining lights were some sort of weird code, spelling out a message of golden squares against a black page. He had a crawly feeling along his spine, imagining thousands of other Manhattan nighthawks growing slow and cold and sensitive to light, sitting in their dark rooms, while a whining alto serpent stung them in the brain.

The idea was ludicrous—Dexter had just been shooting off his mouth, firing off more white liberal bullshit. Still, Goodrick didn't feel much like laughing.

Maybe he thought he should call the police . . . call someone.

But then he'd have to get up, dial the phone, talk, and it was so much more pleasant just to sit here and listen to the background static of the universe, to the sad song of a next-to-nothing life.

He remembered how peaceful Afterlife had been, the piano man's pale hands flowing over the keys, like white animals gliding, making a rippling track, and the horn man's eyes rolled up, showing all white under the sunglasses, turned inward toward some pacific

> "What if the music actually did buzz you like that? Tripped some chemical switch and shut you down, brain cell by brain cell."

vision, and the bass man, fingers blurring on the strings, but his head fallen back, gaping, his eyes on the ceiling, as if keeping track of the stars.

This was really happening, he thought. he believed it, yet he couldn't rouse himself to panic. His hands flexed on the arms of the chair, and he swallowed, and he listened. More lights were switched off in the adjoining towers. This was really fucking happening . . . and he wasn't afraid. As a matter of fact, he was beginning to enjoy the feeling. Like a little vacation. Just turn down the volume and response, sit back and let the ol' brain start to mellow like aging cheese.

Wonder what Rachel would say?

Why, she'd be delighted! She hadn't heard the music, after all, and she'd be happy as a goddamn clam to be one of the quick, to have him sit there and fester while she brought over strangers and let them pork her on the living-room carpet. I mean, he wouldn't have any objection, right? Maybe dead guys liked to watch. Maybe . . . His hands started itching, smudged with city dirt. He decided that he had to wash them.

With a mighty effort, feeling like he weighed five hundred pounds, he heaved up to his feet and shuffled toward the bathroom. It took him what seemed a couple of minutes to reach it, to fumble for the wall switch and flick it on. The light almost blinded him and he reeled back against the wall, shading his eyes. Glints and gleams shattering off porcelain, chrome fixtures and tiles, a shrapnel of light blowing toward his retinas. "Aw, Jesus," he said. "Jesus!" Then he caught sight of himself in the mirror. Pasty skin, livenish toored lips, bruised-looking circles around his eyes. Mr. Zombie.

He managed to look away.

He turned on the faucet. Music ran out along with the bright water, and when he stuck his hands under the flow, he couldn't feel the cold water, just the gloomy notation spidering across his skin.

He jerked his hands back and stared at them, watched them dripping glittering bits of alto and drum, bass and piano. After a moment he switched off the light and stood in the cool, blessed dark, listening to the alto playing in the distance, luring his thoughts down and down into a golden crooked tunnel leading nowhere.

One thing he had to admit. Having your vitality turned down to the bottom notch gave you perspective on the whole vital world. Take Rachel, now. She'd come in any minute, all bright and smiling, switching her ass, she'd toss her purse and coat somewhere, give him a perky kiss, ask how the column was going . . . and all the while her sexual engine would be cooling, ticking away the last degrees of heat like how a car engine ticks in the silence of a garage, some vile juice leaking from her. He could see it clearly, the entire spectrum of her deceit, see it without feeling either helpless rage or frustration, but rather registering it as an untenable state of affairs. Something would have to be done. That was obvious. It was surprising he'd never come to that conclusion before . . . or maybe not so surprising. He'd been too agitated, too emotional. Now . . . now change was possible. He would have to talk to Rachel, to work things out differently. Actually, he thought, a talk wouldn't be necessary. Just a little listening experience, and she'd get with the program.

He hated to leave the soothing darkness of the bathroom, but he felt he should finish the column . . . just to tie up loose ends. He went back into the

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ticipated in a limited way in IAEA safeguards. China likewise remained outside the treaty. The armed five have not changed, but their arsenals have. "In 1946," recalls a Soviet expert somewhat wistfully, "the U.S. had only three atom bombs. There was no mention of a hydrogen bomb. Now the five of us may be reaching 100,000 warheads. The whole history is one of proliferation."

Watching this exponential rise in weaponry, it surprised no one that India, perhaps annoyed by China's greater status, stayed away from a treaty that seemed to penalize developing nations. Nor was anyone surprised when India detonated its first (and evidently, only) nuclear device in 1974.

Other nontreaty nations also seemed to want a bomb of their own. Israel was viewed as an able contender, suspected of fashioning a last-resort deterrent with the help of American sympathizers in the nuclear industry. South Africa, increasingly outcast, developed a high-tech process to enrich uranium and was believed to have embarked upon a secret weapons program—although the world wondered who the enemy could be. Envy propelled the other suspects. Pakistan could not rest while India had nuclear superiority. Taiwan tossed and turned, thinking bitterly of China's large but mainly defensive arsenal. Brazil and Argentina, which have never ignited their mutual dislike in a war, appeared to be in competition to have the first Latin American nuke. Libya, always in the market for new ways to destroy others, was on the bad list. And there was oil-rich Iraq, suspicious but also redeemed—for eight years the enemy of our enemy, Iran.

Much has changed. Safeguards inspectors roam Iraq today with no more courtesy than a pack of junkyard dogs, backed by a toothsome Security Council almost pathologically willing to go back to war over the issue of atomic weapons—in Iraq. Old players have moved up in the queue, promoted from merely suspicious to heavily armed. Others have abandoned their budding weapons programs. Roles have reversed, new players have come swaggering on stage, and others have found Jesus, atomically speaking.

Nothing has altered more fundamentally, however, than the bomb itself—the way it is perceived. Only a year or two ago, nuclear weapons stood ominously at the very center of human affairs. Now, incredibly, it is possible for experts to speak of them as a poor man's weapon of terror, fossil technology—as irrelevant.

Kosta Tsipis, the Greek-born physicist who directs Massachusetts Institute of Technology's Program in Science and Technology for International Security, is among the most emphatically dismissive. "By the end of the century," he says, "nuclear weapons will begin to become benignly neglected. Those who have them will have them, but there will be no new delivery systems. There will still be silos and submarines, but they won't be important." Tsipis is in his fifties, a tall, cranelike man with a shock of thick, gray hair and an angular face in which there remains a droll trace of the boy. "The nuclear thing is an anachronism," he says. "It's silly."

A Soviet official in Vienna, speaking frankly over the ubiquitous decanters of coffee and mineral water, echoes Tsipis. Nearing retirement, he has seen it all, and yet, as with many former Soviets—"I don't know what you should call us at the moment," he laughs—he sees the world with fresh and unambiguously democratic eyes. "Take the entire history of nonproliferation," he muses, choosing his American-flavored English with care. "Both superpowers have not given enough priority to this; it was always a second-class subject." The two sides, he says, had other priorities. "The United States helping Pakistan, the Soviet Union playing with India to counterbalance China." A pause. "Nuclear nonproliferation has been on the margin. Each summit issued statements, but no one really understands that nuclear nonproliferation *is* the nuclear problem." And yet, he feels, the bomb itself will become increasingly irrelevant to the human situation. "In all the wars since World War II, there was a widespread recognition of the uselessness of nuclear weapons. It became a nonweapon on August 6, 1945"—the date of the Hiroshima bomb.

> "Taiwan tossed and turned, thinking bitterly of China's large arsenal. Brazil and Argentina seemed to compete for Latin America's first nuke."

To others, however, nothing has changed but the size and nationality of the nuclear shadow looming over humankind, among them Gary Milhollin, the slender, confident law professor who directs the Wisconsin Project on Nuclear Arms Control, headquartered in Washington, D.C. "Our theory," Milhollin explains, "is unless there is public exposure of nuclear deals, they will continue to happen. Dangerous nuclear deals. Transparency is the best defense to the spread of bombs. We learned in the Gulf War that conventional weapons are the leading edge. Nuclear bombs have become low tech." According to Milhollin, people who are thinking about wars will want smart weapons. "Terrorists will want nuclear bombs. They are attractive to people who want to inflict harm indiscriminately, the military pygmies," he says—some of them muscular pygmies like Iraq.

That desert dictatorship is the past and chilling present of clandestine bomb making—and also the herald for what lies ahead. In this wealthy, determined, seemingly irrational country, one discovers the profile of the true nuclear outlaw. Iraq's nuclear weapons ambitions were said to have been extinguished by Operation Desert Storm. And there, but for the convenient surfacing of a knowledgeable detector, the matter might have rested. Instead, guided by the detector's information, inspectors discovered that Iraq had spent a decade and a few billion dollars pursuing a broad, brilliant nuclear weapons program. "They managed to fool everybody," says Leslie Thorne, a recently retired senior safeguards man recalled to Vienna to lead inspection teams into the desert. The quiet Northumberlander is not a confrontational man and has not become a household word. But he has spent a good deal of time in Iraq, before and since the war, and knows the territory and its people intimately. "We don't underestimate them," he says. "We've met these guys, the nuclear people are very good, well qualified, and they can think originally."

How far were the Iraqis from a bomb? Estimates vary. Tsipis maintains they were still a decade away. Zifferero thinks that time had about run out. "Not enough fissile material," he says, "but rather advanced in so-called weaponization technology. You can study how to make a weapon without having fissile material. Studies of metals, implosions, high explosives . . . they were rather advanced in this kind of technology. As soon as they could obtain fissile materials, they would immediately have been able to assemble a weapon." A true nuclear arsenal—and a

means of delivering it—appears to have been several years in the future.

What is not generally appreciated is that, in terms of its participation in the nonproliferation pact, Iraq did little that was wrong. "Iraq's only noncompliance," says Jon Jennekens, the IAEA's Canadian deputy director-general for safeguards, "was its failure to declare the enrichment program. It also did not declare that it was irradiating uranium to produce plutonium." The only binding agreement is the one for nonproliferation, there is still no international law against building or using nukes. Until there is, most experts agree, there will be countries like Iraq to build them.

For Iraq has given face, motive, and character to the mythic figure of the secret bomb maker and has demonstrated what it takes: the willingness to lie unblinkingly to colleagues, energy and money to burn (but less, perhaps, than one needs to field a flock of smart-bombed F-16s); the conviction that, sooner or later, success will come—in clandestine bomb building, as in all things, patience is a virtue. There must be an Edward Teller; in Iraq, that figure appears to be the articulate, imaginative Jaffar Dhia Jaffar, leader of the Manhattan Project–like effort reportedly dubbed Petrochemical Project 3. And there must be an infrastructure of talented physicists, chemists, engineers, and technicians capable of thinking on their feet. Finally, the program must run from material acquired outside the safeguards net.

In the world before the discoveries in Iraq, such a program could operate undetected for many years—even with a kind of general certitude by worldwide intelligence organizations that the country wanted nuclear weapons. Who will be the next Iraq? Here are the players, the heroes and villains, of our nuclear future.

The weapons powers. Still the same old group of five, still armed to the teeth, these nations are suddenly volatile. The United States and Soviet Union spent a decade squeezing out small increments of nuclear disarmament. Then, in autumn 1991, they began a series of bold, unilateral pledges to strip away their nuclear arsenals. Even before the Soviet Union exploded into its republics, creating a litter of new, less predictable weapons states, the two superpowers moved most quickly to divest themselves of small, tactical weapons—warheads that yield the explosive power of the Hiroshima bomb, but can be carried in the trunk of a Honda. No one knows how far such cuts will go, but hardly anyone wants them to slide to zero. Disarmament, it seems, holds some big surprises, much as the easing of East-West tensions did.

"I think there's a risk that the Russian military establishment may go up for sale," Milhollin says. "One can imagine teams of Russian bomb designers in a country that could afford them."

MIT's Tsipis also frets about idle Soviet brainpower. "The Russians have several weapons labs with superb scientists," he says. "They are all of a sudden assigning patents to themselves. They are peddling technologies developed in their weapons programs. In early September, they came to Cambridge offering technology on chemical extraction of transuranic elements. 'Only good for weapons.' He shakes his head. 'Entrepreneurial Russian scientists. 'Give us an order,' the Russians say. 'We'll produce it for you.' It's almost

> "Only a year ago nuclear weapons stood ominously at the very center of human affairs. Now, incredibly, experts speak of them as a poor man's weapon of terror—fossil technology."

like Livermore and Sandia going into the open market."

Not only are the Russians going into the market—they are going in on the cheap, according to an American government official. "The Sovs are out there scaring the shit out of the West because you hear, 'Ten thousand dollars a year per scientist, we'll do R and D for you.' Shitty equipment, compared to the West, but there the price is 15 or 20 times as much."

Not everyone thinks this is a problem. "When the West and the Soviet Union laid off a lot of people 20 years ago, you didn't see it happen then," Thorne says. "No need for them, since the countries were going for smaller weapons. Some became safeguards inspectors. One or two were employed by other countries: Brazil, Argentina. Working in atomic energy, mostly." He grins. "Iraqis are concerned about being out of work, very bitter about it. These same guys who've been lying through their teeth will cry on your shoulder about the sites being destroyed, no jobs." The Iraqi bomb makers may be the truly dangerous unemployed. As one IAEA official puts it, "You can't safeguard a mind." Dr. Al Strangelove, perhaps.

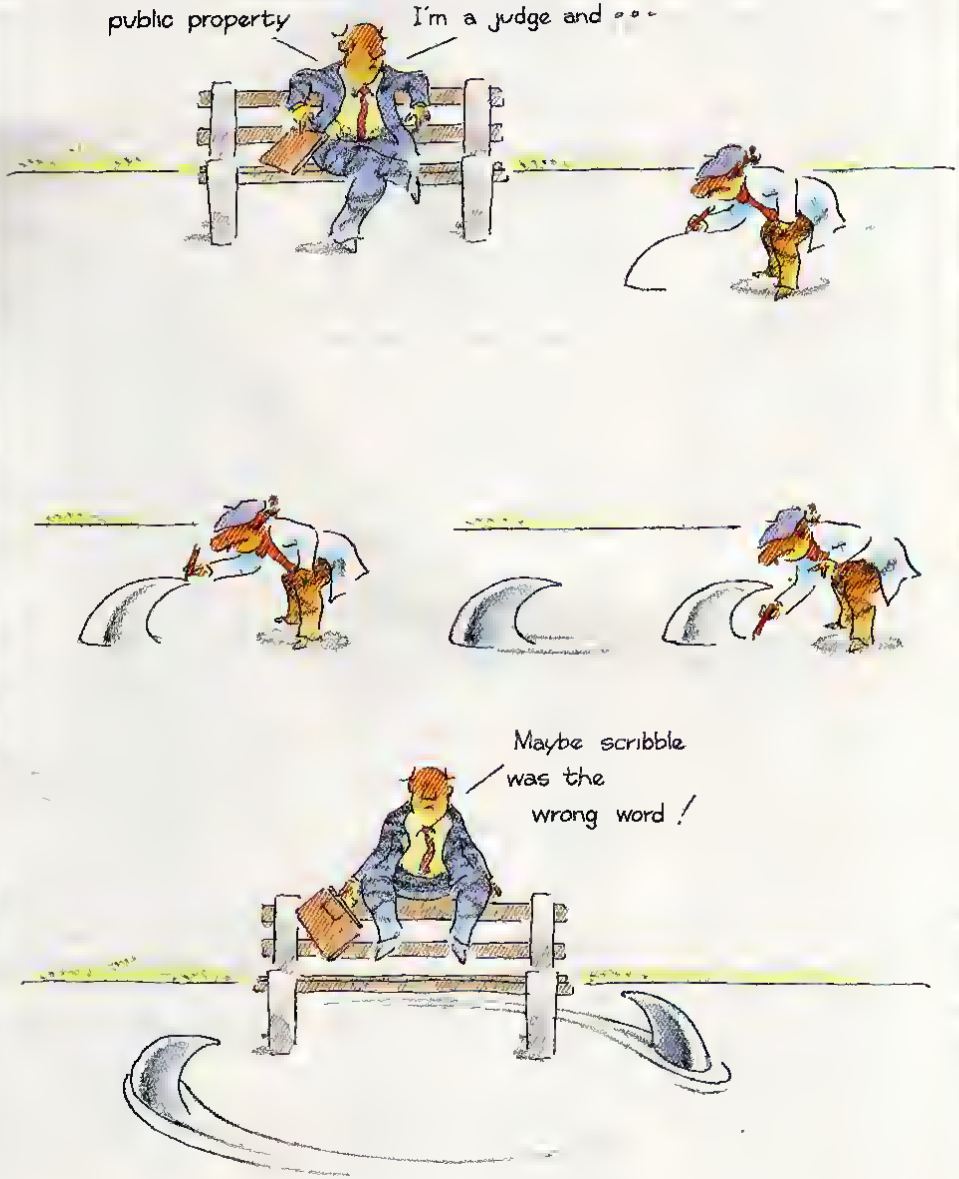
Despite such worries, nuclear disarmament appears to be the wave of the present and near future, almost certainly because the dynamics of deterrence are being viewed in the hard light of a new realpolitik. "I'll tell you a true story," Tsipis says, by way of making the point. "A bunch of Soviet scientists were in Moscow in 1986. At an elegant party all the good guys were there, and there was this discussion between Gorbachev and an American scientist. The American asks, 'Why so many warheads? Why thousands? Why not 50, or 10?' Gorbachev says, 'We need 6,000.' So the American asks, 'Well, what is it worth to you? Would you give Moscow?' Gorbachev shakes his head. The American keeps going. 'Leningrad? Kiev? Vladivostok?,' listing ten Soviet cities. Gorbachev keeps shaking his head. The American says, 'That's only ten cities. We can defer you with ten warheads. Why do you need more?' But there you are," Tsipis concludes. "You get your deterrent with hundreds, not thousands, of warheads."

In Vienna, a Soviet official echoes Tsipis. "France and Britain keep a modest nuclear program and seem happy with them. Why not Russia the same, for the last resort? The example of France and the U.K. and China, a few small arsenals, a few hundred warheads — what is the minimum for a last resort?"

Scaling down vast arsenals is not the only good news from the weapons states. France and China, which have thus far stayed clear of the nonproliferation pact, have agreed to come into the fold. The bad news is that China, although now apparently ready to ratify, seems to have lost all scruples about spreading nuclear knowledge across the Third World—selling reactors and ballistic missiles to Pakistan and Algeria, for example, and uranium enrichment technology to Iran. Optimists believe the current attitude will soon change but find China's behavior puzzling. Perhaps, ventures one IAEA official hopefully, the Chinese central government is not really in control: perhaps the weapons labs are making deals on their own. Muses another sadly, "China does not seem to care."

Israel. Although not a declared weapon state—Israelis will say officially only that Israel will not be the first to introduce nuclear arms into the Middle East—the beleaguered little nation has moved well up the atomic ladder in recent years. Today Israel is believed to

The Artist



have a broad, sophisticated nuclear arsenal rivaling those of France, Britain, and China, including fusion-boosted atomic bombs, neutron devices (which shower targets with lethal bursts of neutrons but have a mild explosive punch), and even thermonuclear weapons—and the means of delivering them anywhere. Although reported occasionally through the 1960s, the size and complexity of this arsenal was first revealed publicly in 1986 when Mordechai Vanunu, a 31-year-old technician, sold words and pictures describing weapons development at Dimona, in the Negev, to the *Times* of London. Many believed the leak was deliberate, flaunting deterrent where war-minded neighbors could see it. Vanunu, who was seized abroad and returned to Israel where he was sentenced to 18 years in prison, might quibble. Subsequent reports have raised the number of suspected Israeli weapons into the low hundreds—about the quantity many want to be the model for the arsenals of the future.

Israel's enemies. No Arab country can quite ignore the fact of Israel's mighty nuclear sword, and some find it unendurable—Iraq, no doubt, among them. Even in her death throes Israel could destroy the homelands of her assassins, a tactic for which writer Seymour Hersh recently coined the term the Samson Option. But the Arab nations must also find it intolerable to be always so far behind Israel in things technical. Iraq's weapons program must have run partly off that powerful unscratchable itch to outperform a hated rival. So must the perceived nuclear aspirations of Syria, Algeria, and Iran—countries that only a few years ago were not even on the list of prospective bomb builders, but which now appear to be heading toward weapons programs of their own. Libya, the eternal outlaw, remains ill-equipped to develop a bomb at home, but quick with oil money should one—perhaps a tactical warhead lost in the chaos of Soviet disintegration—find its way into the marketplace where nations do their secret buying.

Among these players, the Gorbachev anecdote and its parable of deterrence plays less pleasantly. Would the United Nations trade London for Baghdad? Would America sacrifice Peoria to push an invader from Kuwait? Those crazy tens of thousands of warheads notwithstanding, a stalemate seems to develop very quickly with crude nukes. On the other hand, one must also ask whether anyone would trade a capital city—a Baghdad, a Damascus, a Teheran—for all the cities in Israel. Sad to say, the answer could be yes.

India and Pakistan. Like huge twins joined at the shoulder, they are seldom spoken of separately by people in the nonproliferation game, although the two are very different. Their status has shifted dramatically since the 1974 Indian detonation. Asked about India's nuclear capabilities a decade ago, experts would have replied that the country had once exploded a nuclear device—no doubt as ungainly and unportable as the Trinity bomb of 1945. Without much fuss, however, India has evolved a nuclear industry powerful enough to begin exporting reactors to any who will buy them, and there are at least anecdotal references to more extensive weaponry. Perhaps the most telling is a story heard in Vienna, where a Soviet diplomat jokingly told a high-ranking Indian scientist that they should announce themselves as a weapon state and join the Big Five. The Indian unblinkingly replied that this was precisely what he and his colleagues were trying to persuade their prime minister to do. As though suddenly, India is perceived as having not just a crude atomic device, but a rack of bombs. Behind a translucent veil, India has become a true nuclear power.

Pakistan, the runt of the subcontinental twins, has made news with a chronic nuclear lust ever since the Indian explosion. Like Israel, their bomb, if there really is one, remains an official secret, its existence steadfastly denied by the government—but bragged about by knowledgeable individuals. Pakistan's Edward Teller is Abdel Qadir Khan, who claims that his research program has mastered uranium enrichment. Indeed, he is a national hero for purloining centrifuge secrets from Urenco, a European uranium processing consortium in Holland. He reportedly boasts openly of the size and sophistication of the nuclear arsenal he has created. Not everyone believes him, though. Experts agree that Pakistan has been trying very hard to get a bomb, running a secret weapons project separately from its safeguarded civilian energy program. But they seem not to have used their vaunted centrifuges to go for a uranium weapon, all reports suggest that they have opted instead for a plutonium device, and some say they have failed.

To build a bomb program takes ten years," says Tsipis. For Pakistan, a little more. Good physicists, but lousy engineers. He notes news stories that they have had great difficulty in fashioning the implosion trigger needed for a plutonium bomb.

Milhollin is less sanguine. "I would imagine that Pakistan could deploy on

short notice," he says. "A matter of weeks." Perhaps the clearest sign that Pakistan has finally gotten there is that President Bush, for the first time last year, was unable to certify to the Congress that Pakistan has no nuclear weapons program.

South Africa. While some nuke watchers now say the South Africans were never serious about a bomb, many believe South Africa had fashioned a few bombs, perhaps in cahoots with Israel. Whatever the progress until now, South Africa seems to have renounced the weapon after all and ratified the nonproliferation treaty. A Soviet expert says he thinks they have begun diluting their weapons-grade uranium back to lower levels of U-235. Says an American official, "The nuclear people there want to make sure that if they have anything, it isn't there when they no longer control the government. South Africa could be the proliferation spy who came in from the cold." They may be off the bad list.

Taiwan. One used to hear that this island nation of displaced Chinese would never rest until it had parried mainland China's nukes. Now, what once seemed a nest of secret bomb makers has quietly become respectable. "Taiwan had to decide whether to go its own way," says an American official, "or continue to get economic and technical cooperation from the United States ... and chose the latter."

North Korea. One of the mausolea of communism, this bad-tempered newcomer to the bomb list appears to be the next Iraq ... and the greatest challenge to date of the IAEA's ability to keep the nonproliferation peace. "A lot of people say North Korea is in the first steps of a weapons program," says Michael Wilmshurst, a former British diplomat who until recently headed the IAEA's division of external relations, charged with negotiating the agreements that hold the larger pact together. "Others say that North Korea would do everything underground—they'd use tunnels. I don't think they are going to let the agency resolve this."

North Korea signed the nonproliferation treaty about seven years ago, but not unconditionally, as the agreement requires—they refrained from signing the concomitant safeguards agreement. They have said that negotiations with the United States must come first, to rid South Korea of American nuclear weapons. But even an American pledge to do this has not done the trick—North Korea simply raised the ante, demanding that its southern sister be evicted from the American nuclear umbrella. The research center at Yongbyon remains off-limits to inspectors.

Many believe North Korea's slow shuffle toward a safeguards agreement is intended to buy time for its weapons development program. "They're making weapons for 'defense,'" sneers an American official, not displaying the slightest doubt of North Korea's intentions. "Hard to know what 'defense' means to them. It may be like Hitler was threatened by the Poles."

Tsipis doesn't see a problem, whether or not North Korea builds a bomb. "Suppose North Korea gets an arsenal ... then what?" he asks rhetorically. "Tell South Korea, 'Hand over the jewels.' South Korea says no. Then what? Bomb Seoul? Then they get nothing. Suppose North Korea occupies Japan. Will they be able to sustain the Japanese economy? No. So, what is the gain? You can't force the Japanese to do it. Force doesn't work anymore. Like slavery, human sacrifice, cannibalism ... it's gone."

Just about everyone else believes, based on the record, that North Korea does not care if wanting a bomb is considered irrational, futile, or old-fashioned. "Personally, I am very worried," admits a Soviet diplomat. "I have been there and have some understanding of that mentality." But others, like Wilmshurst, worry less about a North Korean bomb than the chain of diplomatic events that its development could trigger. "If North Korea admits to making weapons, then South Korea will drop out of the NPT obligations, and then perhaps Japan." Such fears may prove groundless. The two Koreas began the new year by concluding a surprise agreement to clear their peninsula of nuclear weapons. It could be real progress, but it could equally be yet another North Korean device to lengthen the fuze on its decision to admit safeguards inspectors.

Japan. The Japanese aversion to all things nuclear is axiomatic—the explosions at Hiroshima and Nagasaki, we have been told since 1945, sealed the national attitude against developing nuclear weapons. And yet, this atomically allergic nation has one of the world's most extensive and advanced programs in nuclear energy—their commitment is second only to that of France. Moreover, they have evidently opted to fuel the future not with imported hydrocarbons, but with home-grown plutonium. Japan pursues the so-called fast-breeder reactor, which is supposed to create more fuel, in the form of plutonium, than it consumes. They also have some of the planet's most advanced ura-

nium enrichment and spent-fuel reprocessing facilities.

Being one of the great nuclear nations technologically, Japan is inevitably seen as being able to throw a bomb together. "They have an aggressive space program," says Milhollin, "and are committed to a plutonium future. They could become a nuclear superpower. They either now have or soon will have the means to put a warhead anywhere in the world. With the breakup of the Soviet empire, Japan and the United States are economic rivals. . . . military force has been used to achieve economic goals. It's not beyond imagination. It could happen.' *It* is a Japan with nuclear weapons.

Thorne can remember that Japan was extremely reluctant to come into the safeguards program in the first place. "In the early 1970s, they wanted nothing to do with nonproliferation. Some of the more extreme technical people saw it as interference in their nuclear industry.' In the medium term, a North Korean bomb is viewed by some Japanese scientists as sufficient impetus to make Japan take up weapons. Looking into the next century, however, the players change. One scenario: Japan is somehow goaded into bomb building not by the actions of neighborhood gangs, but by those of an estranged friend—us.

Germany. One of the ironies of safeguards is that most of the $70-million-a-year effort goes to monitor the nuclear industries of countries like Japan and Germany, both now considered nuclear sweethearts. It was not always this way. "If I had been able to say 20 years ago that 60 to 80 percent would go to Germany and Japan," Thorne muses, and stops, leaving unsaid, I would have gotten a medal. "The Soviet Union wanted safeguards only so it could be applied to the Federal Republic of Germany. They were dead scared that Germany was going for a weapons program. The Soviet Union *really* wanted them under safeguards."

Certainly Germany has tried to be good, and to be seen as doing so. Showered with invective when German entrepreneurs were discovered sneaking technology to such places as Libya and Iraq, Germany passed laws that will put citizens in jail for trading in the material of indiscriminate destruction—nukes. Some argue that the intertwining of Europe's economies effectively neutralizes any German inclinations to tinker with nuclear explosives. On the other hand, there is all that ability. 'Germany, like Japan, has an advanced uranium and plutonium capability," says Milhollin, "and also ICBM development.

capability They could do it very quickly. The big problem for [Germany and Japan] would be for them to do it without our finding out Exposure would likely stop Germany It would be unlikely to stop Japan'

Latin America Only three Latin countries—Argentina Brazil, and possibly Chile are believed capable of building a bomb Of these only Brazil and Argentina have caused concern by developing indigenous sources of enriched uranium—Brazil, especially, appears to have gone "quite a long way' toward weapons development Now they have said their weapons days are over and have asked their congresses to ratify agreements that forswear nuclear weapons, even peaceful explosions and commit both nations to bilateral as well as IAEA safeguards on their entire nuclear programs Asked about the reliability of such regional safeguards Zifferero grins 'When you are a neighbor inspecting a neighbor," he says, "you know where to look " Meanwhile, reports from Chile indicate that Chile has embarked on a program to develop a uranium supply, presumably to fuel a nuclear energy program Overall, however, the chances are excellent that Latin America, a place of legendary instability in many other respects, will become the world's first nuclear weapons free zone.

As it was in the Beginning . . . On its surface the nuclear future looks kinder and gentler than the nuclear past The arsenals that could have destroyed much of the planet's life seem to be shrinking to the cube root of their former numbers The world no longer walks a tightrope strung between two superpowers Former bad guys have expressed interest in returning to the fold Hans Blix, the Swedish director-general of the IAEA, sees the combination of disarmament and the good news from China France, South Africa, Argentina, and Brazil as a sign of a kind of nuclear springtime in the air Certainly the renewal of the Treaty on the Non-proliferation of Nuclear Weapons, set for 1995, is almost a sure thing, despite some carping by countries pushing for a total test ban 'Our ambition is to have complete nuclear nonproliferation by 1995 ' he says "I don't think it is impossible "

But if one takes up the darker strands of this same tapestry, the future looks less friendly Many weapons will remain, and others are clearly on the way It seems only a matter of time before India and Pakistan declare themselves to be nuclear weapon states—there is still no international law against building such weapons, after all

North Korea may also claim weapons status in time and—depending upon the resiliency of the American nuclear umbrella—South Korea may feel it has to follow suit Japan has the means if not the political desire to become the next great military superpower and might be compelled to do so by the regional instabilities created by a nuclear North Korea, or by some other as yet unforeseeable event

Iraq one must assume, is now eternally in the nuclear camp and its acquisition of the bomb is an eventuality, temporarily displaced further into the future Iran Algeria, and Syria have shown signs of the itch there is no chance it will ease while Israel possesses nuclear arms One chilling scenario, put forth by a French IAEA official, envisions an Islamic coalition of secret bomb builders linked to technically adroit Moslems in the Soviet Union, where disintegration may very well create the worst of all possible situations a clutch of small, impoverished weapon states, linked ideologically to the angry oil tycoons of the Gulf

> "Looking into the next century, the players change One scenario Japan is somehow goaded into bomb building not by malicious neighbors, but by an estranged friend—us."

In the meantime, more and more countries begin to turn to the atom for energy, prestige, and technical knowhow—knowhow that inevitably connects to the technology of weapons The genie as they say, is *really* out of the bottle

Critics of the IAEA believe the present safeguards apparatus cannot begin to accommodate this dangerously nuclear future Some want the safeguards function to pass to the U N Security Council, where all teeth ultimately reside For its part, the agency, proud of its expertise and loath to lose turf, has proposed what it calls "enhanced safeguards —a system strengthened by access to intelligence and people to interpret it, a leakproof global watch on the movement of relevant goods license to make unannounced "challenge' inspections, and an end to evenhandedness so that limited resources are diverted from writing parking tickets to chasing outlaws

Not many people believe all—or any—of this can happen in the real world "I remember 1974 India exploding its nuclear device," says Wilmshurst "The concerned community picked up everything and shook it. We looked at the international fuel cycle we formed study groups, and . . . nothing happened All these other new ideas we examined closely and dropped We are no better equipped to deal with the problems on the horizon than we would have been for Iraq without the coalition forces'

Thus, no one imagines North Korea submitting docilely to a challenge inspection of its undeclared nuclear workshop at Yongbyon, or that such angels as Japan and Germany will suffer such intrusions gladly Nor does anyone see the Security Council as going permanently on the warpath—attacking North Korea for example, if it turns out they have a secret weapons program Although the world looks very different on the far side of the Euphrates, it will be approached much as it has always been Sometimes the Security Council will be permitted by consensus to put in its fangs and fight, but most of the time it will have to settle for handing out a good scolding to nuclear renegades As it was when the Israelis raided an unfinished Iraqi reactor eleven years ago, so it is now, and so it may be forever Alarmed nations will have to take matters into their own hands

They will do this, however, in a setting that, in terms of nuclear weapons, will be more like the 1960s than today Powerful bombs will ride aircraft and famously unreliable missiles There will be no pretense, as there was latterly between the superpowers, that these weapons are targeted mainly on military sites These weapons of the future, at least in their early generations, will be about as smart as America's old Atlas ICBM, which is to say not very smart at all There will be no talk of dropping a nuke down somebody's chimney—they will do well to launch the thing in the general direction of a town As fictive nuclear battles between the Soviet Union and United States did 30 years ago, combatants in the atomic world just ahead will win or lose by destroying the opponent's population—by trading cities

Some things never change. ⊠

Carl A Posey writes frequently on topics in science and education His fifth novel *Bushmaster Fall*, a tale of science and espionage set in the rain forest was published in February by Donald I Fine

INTERVIEW

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looking for a rare little monkey-animal named *teutonius*. It was a beautiful place, there were patches of snow, very other-worldly. I suddenly had this premonition so for a whim, I said, "Constance, you're going to find a teutonius jaw with seven teeth." We laughed, then collected for another two hours. We were about to go back to the truck and she leaned against a rock. Right next to her hand was a teutonius jaw with seven teeth.

Omni: What was it like to discover Little Big Foot, of the rare Othnielia family, and the baby brontosaur?

Bakker: The bones of Little Big Foot and the baby brontosaur were initially found by Jim Filla and Jim Siegwarth, from the National Institute of Standards and Technology. I'd only seen one specimen of Little Big Foot in the field in 20 years. Now, in Bosler, a ghost town in Wyoming, these guys find a really good specimen. When Constance and I went to the site, we found lots more jaws and teeth—bizarro teeth that looked like miniature buzz saws arranged in a semicircle. Each tooth has two sides, more like a mammal than a dinosaur tooth. The third time, we found babies, three or four individuals, but no sign of eggshells. I'd never seen a baby brontosaur, although *Brontosaurus* is a common animal. This little guy is about 200 pounds.

Omni: What have you learned about the Age of Dinosaurs from this site?

Bakker: The *Brontosaurus* environment was usually pretty damned dry, but in the Little Big Foot era, it must have been as soggy as New Jersey in the spring rains—full of fish, lungfish, and turtles. The dinosaur party line tells you that the dinosaur ankle is not flexible, can't move or twist. But the Little Big Foot ankle still has a fair amount of flexibility. If you're running on soft, mushy ground with big, spreading feet like Little Big Foot was, you need a flexible ankle, otherwise you'd break it.

Now we've got bits and pieces of a fully adult specimen that would be about six feet long from head to tail and lighter than a lot of Thanksgiving turkeys—pretty damned small. So here's a very small dinosaur in the Jurassic—the age of big dinosaurs—running around with spreading mudshoe feet in a mushy part of the environment, when all around was pretty dry. It gets curiouser and curiouser.

Omni: How did you find the new King of Carnivores, the epanterias?

Bakker: University of Colorado grad student Jim Kirkland, whom I call the "Crocodile Dundee of Dinosaurs," found it. He's legally blind in one eye, but he has the uncanny knack of knowing where fossils will be from miles away. He saw this tiny patch of outcrop in the badlands from the road, and he said, "We should look *there*." And I said, "Why should we go all the way over there?" The first bone he found was a piece of epanterias tail six inches long, which means the whole tail would be 25 feet long, and that is, pardon the expression, a long piece of tail! The tails of meat eaters are very distinctive. So we knew we were on to the only meat eater that big: epanterias. The bone was well preserved but very brittle. It took hundreds of hours to chip it off the rock. Not in my most—I'd say drug-crazed dreams, but I don't take drugs—did I ever expect to find an epanterias. Two have been found in 150 years.

> "Take the minibus to Uganda. How many big, cold-blooded animals do you see? How many herds of tortoises? How many hunting packs of komodo dragons in Indonesia?"

Bigger than Tyrannosaurus Rex and every bit as scary, epanterias is the last allosaur, the final stage in the evolution of that illustrious family. The pattern with dinosaurs is that they evolve quickly, get bigger, and then die out. Tyrannosaurus Rex is the last species of its family, epanterias the last of its genus and family. After that, no more *Allosaurus*. If you pick up your *Golden Book of Dinosaurs*, it talks about Jurassic dinosaurs—*Brontosaurus*, *Allosaurus*—and gives the impression there was one age of dinosaurs when all these animals lived together. That's like talking about Egyptian history as if there was the priest, the Pharoah, and the pyramid. Period. There wasn't one age of the Jurassic; there were five or six, separated by change, extinction, evolution, new animal species moving in. The very last Pharaoh of the Morrison dynasty, epanterias, was probably big enough to threaten a brontosaur. That was not true of the previous five or six Pharaohs.

Omni: You've said you count the days until you can set off to dig. Would you rather be in the field than on TV?

Bakker: No, because TV is a way of teaching. It's important to share information, and the laity ask interesting questions that don't occur to paleontologists.

Omni: When, in the sixties, you saw that dinosaurs had been shoehorned into the wrong paradigm, how did you go about prying them out of it?

Bakker: I said you've got to look at dinosaurs point by point, take them apart as if you never saw one before. I did my undergraduate thesis on dinosaur front ends. I dissected frogs, toads, bats, elephant shrews, dogs, cats, two kinds of alligators. Dinosaurs show a clear mechanical similarity to large, fast-running animals. I never take a dinosaur by itself. This morning I was looking at dissections of crocodile and turkey necks to reconstruct the neck muscles of that sauropod we're digging.

People don't compare dinosaurs to other critters. Take the classic orthodox statement, "triceratops couldn't run fast." Why? "Its legs weren't strong enough." Compared to what? Rhinos, hippos, elephants are the biggest animals on the surface of the planet now. Giant tortoises are the biggest terrestrial reptile we've got. What is a triceratops more like—a white rhino or a giant tortoise? It's more like a superrhino. If you want to know how fast a triceratops is, measure how thick and long its legs are. For Pete's sake, and compare it to something running around today. Pound for pound, the triceratops has longer and much thicker legs than a white rhino. Unlike the Pentagon, evolution doesn't overbuild more strength than needed. Animals run as fast as the legs they're given.

Omni: But the rhino is a mammal, and the dinosaur is not.

Bakker: Don't give me this mammal-schmammal business. There are universal truths here! I mean, if it works for mammals, it's got to work for dinosaurs. Orthodoxy says dinosaurs must be slow because they're very big. Is the white rhino slow because it's big? I've been chased by a white rhino in Kruger Game Park in South Africa, and the white rhino was passing the Land Rover.

Omni: Don't paleontologists still classify dinosaurs as reptiles?

Bakker: What the hell does that mean—"They're reptiles"? That's just bloody stupid. Thinking by labels is pop-top vending-machine science. Put a quarter in *reptile*. Ping! Ching! Out it comes—cold-blooded, stupid, and slow. Geez! That pretzel logic could prove the white rhino is cold-blooded.

Omni: So how would you reclassify dinosaurs?

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Bakker Birds, dinosaurs and their close kin belong in one group. You could call it *Dinosauria* or *Hyposauria*, but don't call it reptile. But taking dinosaurs out of *Reptilia* is like burning the flag—it deflates a lot of the orthodox argument. Then if you think about dinosaurs, you're thinking about big birds, not big lizards, crocodiles or cold-blooded hippos.

Omni Don't we have to find a missing link to prove that birds descended from dinosaurs?

Bakker Evolution doesn't proceed by huge jumps. It's a bushy tree with lots of branches. We didn't go from monkey to chimp to your great-great-great-grandmother to you. I can't tell you which dinosaur was the ancestor of birds. I can give you about five dinosaurs that were very birdlike, but the ancestor is probably not one of those. It's probably one we don't know yet, somewhere in between two branches.

Omni The big plastic robotic dinosaurs you've designed for Dinamation are all brightly colored. Why?

Bakker It's sort of jarring—a bright-pink dinosaur, a bright-blue patch on the duckbill. Ooo, what's going on here? Well, we have an envelope of plausibility. If you want to know what color an animal is, your first question is, Is it color blind? If so, it won't evolve bright colors to express social and sexual position. Birds are color-sighted animals, so they evolve this wonderful array of colors to identify species and social rank. I mean, it's important not to waste time courting someone of another species. Unless you're in Southern California, you don't want to do that. Since there are 800 other kinds of birds, also courting, you've got to have a unique, color-coded ID badge.

So, were dinosaurs color sighted? Most certainly, because the only direct descendants of dinosaurs today are birds. The only thing close to an ancestor of the dinosaur is an alligator or crocodile, and they are color sighted too. So the whole family tree of dinosaurs—their friends and relatives—are basically color sighted. If they courted at night, they wouldn't need bright colors. Alligators and crocodiles are not bright, but they are color sighted. Well, they court at night. Since dinosaurs had crests over their faces, visual recognition cues, they were most certainly courting by sight during the day. They were courting *a la bird* rather than *a la gator*. There were bright colors on dinosaurs, particularly on their faces. Which colors, we'll never know, but it certainly would be wrong to spray paint all dinosaurs green, brown or gray.

Omni Your opponents claim that some dinosaurs may have been warm-blooded, but the others had a kind of specialized reptile metabolism.

Bakker That some dinosaurs have a special physiology sounds good in theory—but name one. There are 8,000 species of birds today. Some eat clams, others seeds or fish. Every one is warm-blooded. Every one has a giant heart. Are you going to tell me that an eagle is more warm-blooded than a pigeon? Brontosaur ate plants and was big. Deinonychus was small and ate meat. That means nothing relative to their metabolism.

I've often heard the statement, "Well, there are flaws in the warm-blooded theory." Anyone saying that is missing the point. The real question is, Which theory is stronger? Slow, cold-blooded, stupid? Or fast, warm-blooded, smart? Not one dinosaur bone that's been cut looks like an alligator

> "Triceratops have longer and thicker legs than a white rhino, and unlike the Pentagon, evolution doesn't overbuild. Animals run as fast as the legs they're given."

bone. Every single one has shown the animal grew fast. If you take these dinosaurs apart, no matter how you cut them, they sure look like big birds.

Omni Your opponents argue that the growth rate tells us nothing about dinosaur physiology.

Bakker Nonsense. How fast does a giant tortoise grow in the Galapagos? Very slowly. A small bird? Very fast. Small, medium, or large warm-bloods grow faster in the wild than small, medium, or large cold-bloods. Take the goddam minibus to Uganda and how many big, cold-blooded animals do you see? Do you see herds of tortoises? Hunting packs of Komodo dragons in Indonesia? Unless you're lucky enough to see a python, you don't see any big cold-bloods. Yet people cling to the central dogma, "Oh, dinosaurs were all big and it was a warm climate, so they didn't have to be warm-blooded." It doesn't wash; we should be beyond this.

Omni Experts disagreeing with you have protested that we can never know the truth about dinosaur physiology because they're extinct.

Bakker Bone is a very faithful tissue and tells many stories. Bones are able to record at least 85 percent of body mass, because every major muscle leaves a mark on a bone. So do the nerves and brain. The thousands of fossil skeletons we have of dinosaurs are a tremendous matrix of information. If you can't answer the major questions with that, then you're either blind, blinded by bias, or not very smart.

Omni Critics accuse you of rejecting scientific terminology. Unlike most paleontologists, you use *Brontosaurus*, not the academically preferred *Apatosaurus*.

Bakker Jargon, I hate jargon, which my field is terribly afflicted with. *Brontosaurus* is the correct name. The name for an animal serves two purposes: one, to communicate; two, to honor the person who discovered the animal. Which is known better to the average second grader? *Brontosaurus*, obviously. Purists say *Apatosaurus* is the older name, but both were coined by the same guy. It's absolute idiocy to insist on *Apatosaurus*; you're not honoring professor Othniel Charles Marsh by using *Apatosaurus*; you're honoring obfuscation, and I hate it. It encapsulates the slavish, dumb, obfuscatory side effects of what I call the priestly language. Jargon.

I know a New York paleontologist who, instead of saying "eye socket," will say *fossa.orbitalis*. That sounds like a German drinking song: [sings in deep baritone] Fos-sa Fos-sa Or-bi-tal-is! Geez! Why the hell cling to a thirteenth-century language that excludes people? *Brontosaurus* is a good name. It means thunder lizard.

Omni What killed the dinosaurs?

Bakker Disease. Disease is probably the biggest killer of animal species in the natural world. Not climatic changes, not big predators, not changes in plants. Historians of human history certainly know that one. For modern paleontologists this is a hackle-raising theory, but it was believed 90 years ago. H. L. Osborn, the first American evolutionary paleontologist who was *the* establishment—this man could strut sitting down—saw dozens of antelope dying of rinderpest and drew the same conclusion in 1900. He pointed out that whenever fauna from one continent mix with fauna from another, disease should cause massive extinctions.

Dinosaurs frequently moved from continent to continent, maybe every million or two years there were waves of immigration and migration. Many parasites have a traveling stage, a cyst, in which they can survive in a host. Disease also kills big animals preferentially because they travel more. Warm-blooded

animals have more diseases than cold-bloods. Mass die-offs of dinosaurs seem inevitable if the faunas mixed, and they did.

When we studied the Big Horn basin it was chock-full of extinction events. There wasn't one age of *Brontosaurus* there were four or five. And each seems to have collapsed pretty suddenly. There may have been 60 extinctions in the total reign of the dinosaur. I think extinctions were common, catastrophic and sudden, and the dominant species got wiped out without any warning. Disease kills more quickly than anything else, and there are so many kinds of diseases. But extraterrestrial events, like exploding asteroids, are more popular.

Omni: Where are the hot spots for dinosaurology right now?

Bakker: Dinosaurs you've heard about—*Brontosaurus, Allosaurus*—are from just a few clumps in history. Most of dinosaur history is still in the Dark Ages, there are no specimens. The Chinese are filling in one of the most important gaps. In central China, Sichuan, they have middle-Jurassic dinosaurs, which no one else has, at least not good ones. Truly missing links, whole missing chains! New species, genera, families—things we never imagined! But we're a hundred years ahead of the Chinese in exploring. We're able to refine our vision and look at better and better close-ups of dinosaur evolution. In North America we can provide a more richly textured matrix of data about dinosaur patterns of success and extinction.

Omni: What would most benefit the study of dinosaurs now?

Bakker: More amateurs. It used to be that most dinosaurs were studied by unpaid professionals. Now the field tends to discourage amateurs. If an amateur goes to the American Museum of Natural History in New York and says, "I want to look at your research collection," they won't let you in. Paleontology has become a closed club. Yet some of the best of us don't have degrees. Dinosaurology needs an army, like the ornithologists. There are about 50,000 good bird watchers in North America alone, and they're extremely efficient and productive in a scholarly way. Because bird watchers make a season-by-season census, we now know that songbirds are going extinct and why. We need that for dinosaurs: an army of people who know how to tell the species apart and enough anatomy to go into those vaults and catalog a hundred years' backlog of skeletons. Most of the bones studied by Marsh in 1890 are still unpublished and unanalyzed in the Yale basement. You can't find diagrams of most dinosaur bones in books.

Omni: Would you like to see your vision of the dinosaur universally accepted?

Bakker: God, no. Then I'd be the new orthodoxy! The battle is mostly won. *The Golden Book of Dinosaurs*—the most widely distributed book on dinosaurs—is totally different than the one I grew up with. Brontosaur is out of the swamps; it's no longer green. dinosaurs are evolving into birds. That means a hundred million kids worldwide have been correctly informed. The genie is out of the bottle and will never go back in. And if some of my stuffy colleagues refuse to catch up with *The Golden Book*, that's their prerogative.

Omni: What's next?

Bakker: Digging more holes, finding more stuff, throwing more balls for dogs, drawing more pictures. I never know exactly. Peripheral vision is what you need in the sciences. You set a goal, go after it, and soon you find out the important stuff is on the periphery of your goal. Evolution is just too gloriously bushy not to be full of surprises. OO

NIGHT MUSIC

CONTINUED FROM PAGE 74

living room and sat in front of the computer. WBAI had finished replaying the simulcast. He must have been in the john a long time. He switched off the radio so he could hear the music in his head.

"I'm sitting here listening to a little night music, a reedy little whisper of melody leaking out a crack in death's door, and you know, even though I can't hear or think of much of anything except that shivery sliver of sound, it's become more a virtue than a hindrance. It's beginning to order the world in an entirely new way. I don't have to explain it to those of you who are hearing it with me, but for the rest of you, let me shed some light on the experience. One sees . . . clearly. I suppose . . . is the word, yet that doesn't cover it. One is freed from the tangles of inhibition, volatile emotion, and thus can perceive how easy it is to change one's life, and finally one understands that with a very few changes one can achieve a state of calm perfection. A snip here, a tuck taken there, another snip-snip, and suddenly it becomes apparent that there is nothing left to do, absolutely nothing, and one has achieved utter harmony with one's environment."

The screen was glowing too brightly to look at. Goodrick dimmed it. Even the darkness, he realized, had its own peculiar radiance. Bizarre. He drew a deep breath . . . or rather tried to, but his chest didn't move. Cool, he thought, very cool. No moving parts. Just solid calm, white, white calm in a black, black shell, and a little bit of fixing up remaining to do. He was almost there. Wherever *there* was.

A cool alto trickle of pleasure through the rumble of nights.

"I cannot recommend the experience too highly. After all, there's almost no overhead, no troublesome desires, no ugly moods, no loathsome habits . . ."

A click—the front door opening, a sound that seemed to increase the brightness in the room. Footsteps, and then Rachel's voice.

"Wade?"

He could feel her. Hot, sticky, soft. He could feel the suety weights of her breasts, the torsion of her hips, the flexing of live sinews, like music of a kind, a lewd concerto of vitality and deceit.

"There you are!" she said brightly, a streak of hot sound, and came up behind him. She leaned down, hands on his shoulders, and kissed his cheek, a serpent of brown hair coiling across his neck and onto his chest.

"How's the column going?" she asked, moving away.

He cut his eyes toward her. That teardrop ass sheathed in silk, that mind like a sewer running with black bile, that heart like a pound of red raw poisoned hamburger. Those cute little puppies bounding along in front.

The fevered temperature of her soiled flesh brightened everything. Even the air was shining. The shadows were black glares.

"Fine," he said. "Almost finished."

". . . only infinite slow minutes, slow thoughts like curls of smoke, only time, only a flicker of presence, only perfect music that does not exist like smoke . . ."

"So how was the Vanguard?"

He chuckled. "Didn't you catch it on the radio?"

A pause. "No. I was busy."

Busy, uh-huh. Hips thrusting up from a rumpled sheet, sleek with sweat, mouth full of tongue, breasts rolling fatly, big ass flattening.

"It was good for me," he said.

A nervous giggle.

"Very good," he said. "The best."

He examined his feelings. All in order, all under control . . . what there was of them. A few splinters of despair, a fragment of anger, some shards of love. Not enough to matter, not enough to impair judgment.

"Are you okay? You sound funny."

"I'm fine," he said, feeling a creepy, secretive tingle of delight. "Want to hear the Vanguard set? I taped it."

"Sure . . . but aren't you sleepy? I can hear it tomorrow."

"I'm fine."

He switched on the recorder. The computer screen was blazing like a white sun . . . the crackling of a black storm, the red thread of a fire on a distant ridge, the whole world irradiated by a mystic vibration, the quickened inches of the flesh becoming cool and easy, the White Nile of the calmed mind flowing everywhere . . ."

"Like it?" he asked. She had walked over to the window and was standing facing it, gazing out at the city.

"It's . . . curious," she said. "I don't know if I like it, but it's effective."

Was that a hint of entranced dullness in her voice? Or was it merely distraction? Open those ears wide, baby, and let that ol' black magic take over.

". . . just listen, just let it flow in, let it fill the empty spaces in your brain with muttering, cluttering bassy blunders and a crooked wire of brassy red snake fluid, let it cozy around and coil up inside your skull . . ."

The column just couldn't hold his in-

terest. Who the hell was going to read it, anyway? His place was with Rachel, helping her through the rough spots of the transition, the confusion, the unsettled feelings. With difficulty, he got to his feet and walked over to Rachel. Put his hands on her hips. She tensed, then relaxed against him. Then she tensed again. He looked out over the top of her head at Manhattan. Only a few lights showing. The message growing simpler and simpler. Dot, dot, dot. Stop. Dot, dot, dot. Stop.

Stop.

"Can we talk, Wade?"

"Listen to the music, baby."

"No . . . really. We have to talk!"

She tried to pull away from him, but he held her, his fingers hooked on her hipbones.

"It'll keep 'til morning," he said.

"I don't think so." She turned to face him, fixed him with her intricate green eyes. "I've been putting this off too long already." Her mouth opened, as if she were going to speak, but then she looked away. "I'm so sorry," she said after a considerable pause.

He knew what was coming, and he didn't want to hear it. Couldn't she just wait? In a few minutes she'd begin to understand, to know what he knew. Christ, couldn't she wait?

"Listen," he said. "Okay? Listen to the music and then we'll talk."

"God, Wade! What is it with you and this dumb music?"

She started to flounce off, but he caught her by the arm.

"If you give it a chance, you'll see what I mean," he said. "But it takes a while. You have to give it time."

"What are you talking about?"

"The music . . . it's really something. It does something."

"Oh, God, Wade! This is important!"

She fought against his grip.

"I know," he said, "I know it is. But just do this first. Do it for me."

"All right, all right! If it'll make you happy." She heaved a sigh, made a visible effort at focusing on the music, her head tipped to the side . . . but only for a couple of seconds.

"I can't listen," she said. "There's too much on my mind."

"You're not trying."

"Oh, Wade," she said, her chin quivering, a catch in her voice. "I've been trying, I really have. You don't know. Please! Let's just sit down and . . . ." She let out another sigh. "Please. I need to talk with you."

He had to calm her, to let his calm generate and flow inside her. He put a hand on the back of her neck, forced her head down on his shoulder. She struggled, but he kept up a firm pressure.

"Let me go, damn it!" she said, her voice muffled. "Let me go!" Then, after a moment. "You're smothering me."

He let her lift her head.

"What's wrong with you, Wade?"

There was confusion and fright in her face, and he wanted to soothe her, to take away all her anxieties.

"Nothing's wrong," he said with the sedated piety of a priest. "I just want you to listen. Tomorrow morning . . ."

"I don't want to listen. Can't you understand that? I don't. Want. To listen. Now let me go."

"I'm doing this for you, baby."

"For me? Are you nuts? Let me go!"

"I can't, baby. I just can't."

She tried to twist free again, but he refused to release her.

"All right, all right! I was trying to avoid a scene, but if that's how you want it!" She tossed back her hair, glared at him defiantly. "I'm leaving . . ."

> "The light was streaming up from everything, whitening the air, whiting out hope, truth, beauty, sadness, joy, everything except the music."

He couldn't let her say it and spoil the evening, he couldn't let her disrupt the healing process. Without anger, without bitterness, but rather with the precision and control of someone trimming a hedge, he backhanded her, nailed her flush on the jaw with all his strength, snapping her head about. She went hard against the thick window glass, the back of her skull impacting with a sharp crack, and then she slumped to the floor, her head twisted at an improbable angle.

Snip, snip.

He stood waiting for grief and fear to flood in, but he felt only a wave of serenity as palpable as a stream of cool water, as a cool golden passage on a distant horn.

Snip.

The shape of his life was perfected. Rachel's too.

Lying there, pale lips parted, face rapt and slack, drained of lust and emotions, she was beautiful. A trickle of blood eeled from her hairline, and Goodrick realized that the pattern it made echoed the alto line exactly, that the music was leaking from her, signaling the minimal continuance of her life. She wasn't dead, she had merely suffered a neccessary reduction. He sensed the edgy crackle of her thoughts, like the intermittent popping of a fire gone to embers.

"It's okay, baby. It's okay." He put an arm under her back and lifted her, supporting her about the waist. Then he hauled her over to the sofa. He helped her to sit, and sat beside her, an arm about her shoulders. Her head lolled heavily against his, the softness of her breast pressed into his arm. He could hear the music coming from her, along with the electric wrack and tumble of her thoughts. They had never been closer than they were right now, he thought.

He wanted to say something, to tell her how much he loved her, but found that he could no longer speak, his throat muscles slack and useless.

Well, that was okay.

Rachel knew how he felt, anyway.

But if he could speak, he'd tell her that he'd always known they could work things out, that though they'd had their problems, they were made for each other.

The light was growing incandescent, as if having your life ultimately simplified admitted you to a dimension of blazing whiteness. It was streaming up from everything, from the radio, the television, from Rachel's parted lips, from every surface, whitening the air, the night whiting out hope, truth, beauty, sadness, joy, leaving room for nothing except the music, which was swelling in volume, stifling thought, becoming a kind of thirsting presence inside him. It was sort of too bad, he said to himself, that things had to be like this, that they couldn't have made it in the usual way, but then he guessed it was all for the best, that this way at least there was no chance of screwing anything up.

Jesus, the goddamn light was killing his eyes! Might have known, he thought, there'd be some fly in the ointment, that perfection didn't measure up to its rep.

He held onto Rachel tightly, whispering endearments, saying, "Baby, it'll be okay in a minute, just lie back, just take it easy," trying to reassure her, to help her through this part of things. He could tell the light was bothering her as well by the way she buried her face in the crook of his neck.

If this shit kept up, he thought, he was going to have to buy them both some sunglasses. **DO**

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Color Separations By: Spectrum Inc , Golden, CO

International Space Year 1992