ARTHUR C. CLARKE ON GIANT SQUIDS

OMNI

JANUARY 1992

51

THINGS YOU MUST KNOW ABOUT YOUR FUTURE

REPORT CARD ON THE PLANET • MAPPING OUR MINDSCAPE • COMPREHENDING CHAOS & FICTION BY URSULA K. LE GUIN

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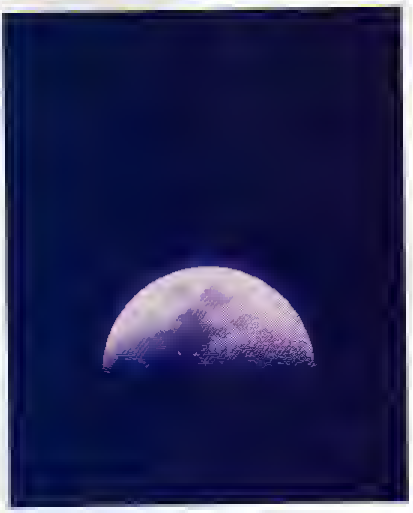
OMNI

VOL. 14 NO. 4 JANUARY 1992

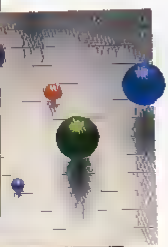
DEPARTMENTS

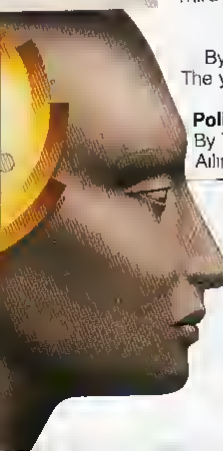


COVER

This month's cover is a departure for *Omni*, highlighting our list of important things to know (Additional art and photo credits, page 97)

FEATURES





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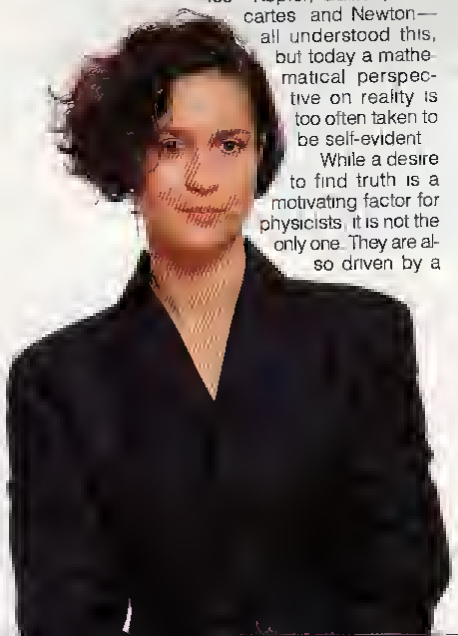
FIRST WORD

UNIVERSAL HARMONY:
The search for a mathematical description of everything

By Margaret Wertheim

We are living in a unique moment of history, for many physicists believe they are on the verge of finding a complete mathematical description of the Universe—a Theory of Everything. Encompassed in its graceful equations supposedly will be our past, our present and our future.

The question that needs to be asked is why are we doing it? We as individuals and our society as a whole—why are we looking for a mathematical description of the Universe? The usual answer is that physicists are searching for truth and so the Theory of Everything will be the Ultimate Truth. However this presupposes that mathematics is sufficient to describe the totality of existence. But how do we know it is? The fact is we don't. The belief that it is remains just that—a belief. The founders of modern physics—Kepler, Galileo, Descartes and Newton—all understood this, but today a mathematical perspective on reality is too often taken to be self-evident.



Wertheim, filmmaker and science journalist, is writing Pythagoras' Dream, a book about the attempt by physicists to describe the universe in the language of mathematics.

While a desire to find truth is a motivating factor for physicists, it is not the only one. They are also driven by a desire to find an aesthetically pleasing and spiritually satisfying description of the Universe—it's just that they use the language of numbers not letters. The great quantum physicist Paul Dirac, whose equations predicted the the existence of antimatter, once said, "It is more important to have beauty in one's equations than to have them fit experiment." From the beginning of the modern age of cosmology in the sixteenth century the quest for a mathematical description of the Universe has been predominantly a spiritual one. Its underlying philosophy is that truth is beauty and beauty is truth, and both can be expressed as mathematical formulas.

For this reason, physics is one of the great aesthetic pursuits of our time. Like Giotto's frescoes, Michelangelo's sculptures, and Bach's fugues, the Theory of Everything is a high point of Western culture. Some of the best mathematicians and physicists today are engaged in constructing it, and all sorts of new mathematics are being developed for the purpose. If they succeed then their theory will be a concrete expression of the ancient Pythagorean belief that the Universe is a vast harmonic system.

The models physicists are now developing in working toward their Theory of Everything do portray a Universe full of patterns and symmetries—a harmonic Universe that is mathematically beautiful. It is this theoretical beauty more than any hard evidence that convinces them they are on the right track. And it's not hard to see why.

Today, according to physics, the Universe is a multidimensional force field, and everything that exists is a concentrated vibration in this field. All things come from the field, and to it they return. It is everything that is, and yet it is empty, for the Universe contains nothing but itself. We are all part of it, not separate entities but interconnected vibrations participating in the whole. Protons, petunias, and people, galaxies and gazelles—we're all harmonies in the universal song.

Some physicists believe that as well as describing how the Universe came to be the way it is, the Theory of Everything will also explain why it did. If we interpret it not just as a description but also as an explanation of why our Universe came to exist, then we will find ourselves in the metaphysical domain. And so we must ask, will a mathematical Theory of Everything be a spiritually satisfying account of existence? This is not something that scientists alone can decide. Since Western culture has largely abandoned mythological and religious accounts of existence, the mathematical ones have come to play a key role in the psyche of our society. Space, time, and matter, change and possibility are all now defined in mathematical terms. Our horizons, limitations, and dreams are being shaped by physicists' equations. We need to assess this mathematical account not just as scientific theory but also as a metaphysical framework for our lives.

The Theory of Everything is an extraordinary construct whose scope and power challenge us to confront it head-on. The view from its summit will be breathtakingly beautiful. The challenge facing us will be to survey what we see and assess what it means to us—emotionally, spiritually, scientifically. In doing so, we will find ourselves confronted with a choice of whether we want to stop there, atop the peak of Mount Everything, or if we wish to press on—and if so, where? That challenge is not just for scientists, it is for us all. ☒

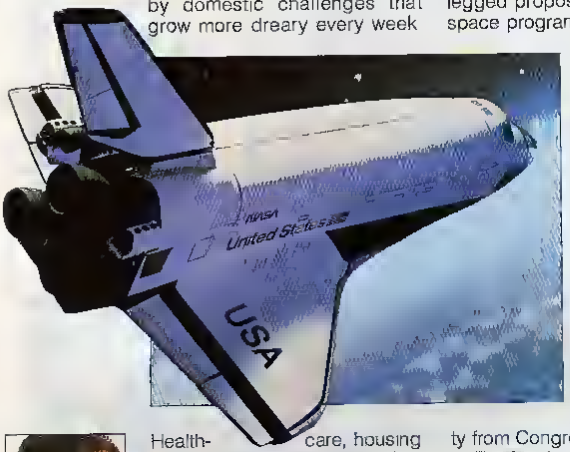
FORUM

VOTE FOR VISION

Are there visionary candidates? Are there politicians who know what space exploration means to the nation and the world?

As we enter Election Year 1992, it would be nice if our officials—those in office and those seeking to be—gave some serious thought to the future of our space program. Nice, but unlikely.

We're in the heart of a recession that may in actuality be a depression. Certainly we are beset by domestic challenges that grow more dreary every week.



A call to act on renewing our space program just might be an effective election year issue.

Health-care, housing, education, unemployment, AIDS, and more—can we afford to continue dreaming about a space-based future?

Can we afford not to? Surrendering one of our noblest dreams may be the costliest defeat we ever suffer. Keeping that dream alive, on the other hand, is unlikely to bankrupt the nation or take money away from social programs. Even an ambitious space program need cost only a fraction of what we're spending on social programs.

What costs more is aimlessness, a lack of direction and purpose. We've spun our space program wheels, as it were, for more than a decade, letting bureaucrats sap the scientific and engineering heart of the undertaking. It's tough to create technology to bureaucratic design, although we've certainly tried in this country. Now it's past time to try something different: a space program based on engineering realities, commercial needs, scientific goals, broad vision. Past time, but not yet too late.

How about a modest, four-legged proposal for getting our space program in motion again, and maintaining its momentum once it begins to move? Fundamental to the proposals is the idea of steady state funding. Engineering projects work best and most economically when they are undertaken with funds in hand, rather than having to take hat in hand every year to beg for continuity from Congress.

The first leg is a revamping of our launch systems. Already under way, the revamping needs to be funded at realistic and *constant* levels, and at levels high enough to provide for unmanned heavy-lift vehicles for lobbing large payloads into orbit as well as smaller and more economical vehicles for bearing humans to space and back.

Second among the priorities is a serious resumption, fully funded, of deep-space robotic missions to the planets and bodies of our solar system. No other undertaking—not even humans in space—costs so little and does as much to fuel dreams as the sight of distant worlds, the sense of astronomical vistas, the flow of information from elsewhere in our system. This is affordable vision at its best.

Third, is some sensible, *firm*, comfortably funded plans for the future of humans beyond our gravity well. Are we or are we not building a space station, and what is its *primary* purpose? Is our next long-term goal a return to the moon or a trip to Mars? Will we be making these journeys on our own or in international partnership? These questions must be answered, firmly and with some sense of finality, in the next 24 months so that we can *get going*. And once we're going, funding must remain constant. Let's treat these as engineering and scientific challenges, not political footballs constantly in motion from one committee to the next.

Fourth is a schedule of substantial tax incentives for private investment in the commercial and industrial development of orbital space. Serious tax cuts for space investment will bring serious investors into the space business. And that will mean jobs, which the country sorely needs.

All of this implies a willingness on the part of the people to take a long-range view. I think the people are more than ready, it's the politicians who are thinking in the short term on this issue. Do we have politicians who dream of leadership or only of leading in the polls? Could we find a candidate who can call on our spirit of adventure, who's willing to take a few risks in exchange for the possibility of large rewards for the nation and the world?

Difficult times demand dreamers, vital challenges call for visionaries. I've listed no specific dollar figures here. That's a job for the politicians. Are there candidates out there who are ready to help the world go *out there?* We'd love to hear from them.

—Keith Ferrell

COMMUNICATIONS

READERS' WRITES

Omni's evolution issue stirs the passions of all persuasions

Creation vs. Evolution

I enjoyed Keith Ferrell's article "The Chasm of Creationism" [Forum, October 1991] and I agree with him 100 percent. What I would like to see is religion change and keep up with the science of the day instead of trying to take us back to the Dark Ages.

Patricia Kameika
Bay Shore, NY

As one who is trained in both science and theology, I was intrigued by Keith Ferrell's article "The Chasm of Creationism." Though I am not a proponent of creationism, and I agree with Ferrell's conclusion regarding opposition to the teaching of creationism in the public schools, I found his argument to be subject to the same dogmatic thinking that he labels as unscientific. While it may be true that evolutionary theory has none of the normal trappings that are usually associated with religion, the theory itself carries with it some definite theological assumptions. To suggest that "faith is personal, science universal" and that "faith is subjective, science objective" is not only debatable in and of itself, but it betrays a lack of theological acumen.

The Rev. Steven E. King
LaSalle, MN

Blood Typ-o

Check Continuum, October 1991, page 28. There are approximately five to six quarts of blood in the average human body. This comes to 5 percent (1/20) to 7 percent (7/100) of body weight, not one sixth. At your estimate, the body of a woman weighing 135 pounds would contain 22.5 quarts or 5.5 gallons of blood instead of approximately 5.5 quarts or about 1¼ gallons.

Elizabeth Hauptli
Dubuque, IA

Semicorrect

I read with interest, and agreement, Tom Dworetzky's column [Political Science, September 1991]. One paragraph, however, needs clarification. SEMATECH's mission is not limited to manufacturing technologies for .35-micron random access memory chips. The technologies we are developing can be applied to a wide range of end products. SEMATECH has suffered from the public perception that we were formed to restore America's presence in the DRAM marketplace. Rather, we were formed to provide the U.S. industry the domestic capability for world leadership in semiconductor manufacturing.

Miller Bonner
SEMATECH
Austin, TX

Dinosaur Debris

It seems to me that with such a preponderance of "strike zones" claiming responsibility for the death of the dinosaurs [Earth, October 1991], the real culprit may have been a "wild pitch." If the real killer were a dust cloud depriving the earth of heat, light, and oxygen, then why would the culprit have to have struck the earth at all? Why couldn't a pair of asteroids or meteors have collided in space, causing the same results? The earth's gravity could have attracted not only enough resulting dust to blind the sun, but also enough larger sized pieces of debris to account for several of the "pretenders" claiming responsibility.

Robert J. Mika
Las Vegas, NV

More on RU 486

I am a 16-year-old high-school student writing to commend Thomas Bass' interview with Etienne-Emile Baulieu in your September issue. Hundreds of thousands of children die each day from malnutrition in overpopulated countries where birth control is limited. RU 486 could help. I have a message for anti-abortionists: If being against abortion is one of the most important things on your list, then make your time and energy count. Telling people what to do and what not to do won't make a world of difference, but opening your door to a mother and her child in need will.

Kathy Sigmund
Ontario, Canada

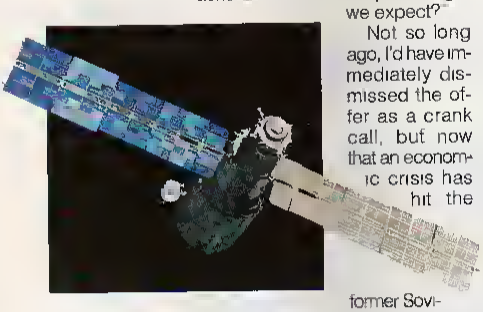
SPACE

PSST! WANNA BUY A SPACESHIP?
Desperate for cash, the Soviets are hocking their spare spacecraft

By James Oberg

The voice on the telephone sounded hesitant and conspiratorial. 'You don't know me,' the caller disclosed unnecessarily, "but I need your advice." Fatalistically but patiently, I asked the man what it was all about. I get a lot of strange calls.

"What do you think we could sell a Soviet spaceship for?" he asked. 'What kind of price might we expect?'



Even the Soviet Union's prized Mir space station may soon go on the block as the space program holds the equivalent of a garage sale.

Not so long ago, I'd have immediately dismissed the offer as a crank call, but now that an economic crisis has hit the former Soviet Union, everything is for sale. The caller provided just enough obscure details about the hardware he was selling and the scientists he represented to earn credibility. Not long ago, the idea of swinging such a deal would have been a cosmic thrill, but such reactions had faded after the tenth or twentieth call.

As gently as I could, I informed my caller that entrepreneurs and even Soviet space officials in search of hard currency have flooded the market with Soviet space vehicles. The equipment he offered was the backup model to the two Fobos probes recently launched towards Mars and its small moonlets, an ambitious international project that promised to assay Martian resources and prove the feasibility of refining rocket fuel on site. Its success could have paved the way for manned interplanetary flight within a decade or two. But both probes had failed miserably, and with the economic crisis precluding a second try, space officials tossed the backup hardware on the scrap heap to be sold for a few cents on the ruble.

The Fobos probe is a recent addition to an intriguing list that visiting Soviet scientists began handing out to Western space museums. It describes seventeen spacecraft and engineering mockups for sale but gives no prices.

Among the entries a demonstration mockup of a Soyuz landing craft 'with three dummies on stand', a Soyuz-TM spacecraft demonstrated in France in 1988, four actual manned vehicles flown in 1987 and 1988, a nose section of a Vertikal probe, a 1:5 scale model of the Buran shuttle, and, for the truly ambitious, a pair of full-scale Energiya superbooster mockups—you pay for transportation.

Despite the Soviets' efforts, actual sales have been rare. A Sputnik replica sold for $10,000, and a Japanese concern snapped up a Mir space station module for more than two million dollars and then quickly resold it to a museum. By and large, potential customers have balked at the multi-million-dollar price tags on the other spacecraft. One Soviet group has demanded $1.6 million for a backup Venus probe and received not even a nibble.

"The Japanese ruined the market with that Mir deal," complains Fred Durant, the former top official of the Smithsonian's Air & Space Museum and now one of the world's leading authorities on spaceflight memorabilia and space art. "I'd have paid $150,000 to $200,000 for a flown Vostok," he says, but so far none have been sold. Much of the equipment for sale is somewhat unremarkable. "They have so *many* used reentry capsules."

Pricing the equipment has proved next to impossible because there is no sales history on which to base a price scale. Max Ary of the Kansas Cosmosphere had been offered training spacesuits for $10,000 by the manufacturers. "They don't know how to price it,' he says because, under the Communist system, they had no idea themselves how much the suits cost to make. In the course of his dealings with spacecraft purveyors, two groups often offered him the same hardware for prices that differed by as much as a few million dollars.

The spaceship sell-off has its limits, Durant observes. 'It's not like these are the family jewels,' he says, noting that nothing associated with first-in-space Yuri Gagarin is for sale. "There's just so much of the stuff that they'll always have plenty left.'

Other than the vast supply of space equipment, a primary stumbling block to significant sales remains a lack of Western appreciation for Soviet space hardware. But that situation is being remedied even now by an unprecedented series of museum exhibits criss-crossing North America. Hundreds of thousands of Americans will soon know the difference between a Progress and a Prognoz, a Soyuz and a Salyut, and a Mir and a Mriya.

With my survey nearly completed, my phone rang once more. "Jim, listen,' began a journalist I knew from Washington, D.C. "I'm in touch with a Russian at the embassy who's working for a cosmonaut. They've got this Vostok rocket for sale, three million, negotiable. Where do you think we can find a customer?'

Oh no, I thought, not another one. But now at least their prices are negotiable. Maybe they're learning. ◻

BRAVE NEW GENES

Are we ready to shift the course of human evolution by altering our DNA?

By Keith Harary

Advances in genetics could help cure many debilitating illnesses but it could also prompt new types of discrimination as well as governmental control of reproduction.

The scene is an inner-city high school in the distant future. Although the students are all blue-eyed, fair-skinned blonds, they represent a range of racial lineages. The government decided long ago that it was easier to eliminate superficial physical differences between races than to overcome bigotry and prejudice. Most of the students are male and tall because their parents believed that such traits would help their chances of getting ahead in life. But the near-complete dissolution of the earth's ozone layer has led to an epidemic of skin cancer, and a fatal virus that affects only tall blond boys is spreading rapidly. Ninety percent of the students in the class of 2081 may not live to graduate.

As bizarre as this scenario sounds, we may soon be able to guide the course of human evolution. Ongoing genetic research should enable us to cure a host of previously untreatable diseases and perhaps preselect such characteristics as children's sex, hair type, eye color, skin shade, ultimate height and weight, and even such intangibles as disposition. With this prospect looming closer, experts are warning that our technical expertise may be advancing more rapidly than our ability to manage genetic information.

Consider that amniocentesis, widely used to detect genetic abnormalities in developing fetuses, also reveals the baby's gender, and doctors report a surge in the practice of eliminating children of an undesired sex through abortion. "If we can't decide whether it is a legitimate use of prenatal screening to be able to abort based on sex, then how can we hope to decide to abort based on other genetically determined characteristics that we deem undesirable?" says Kelley Thomas, an evolutionary biologist at the University of California at Berkeley.

This question is only a precursor of what is to come. Scientists are now at work on a 15-year effort to map some 100,000 genes spread over our 46 chromosomes. The $3 billion project, called the Human Genome Initiative (HGI), will ultimately provide us with the genetic blueprint of the human race. Once established, it could become routine to type infants against it to identify and manage inherited tendencies toward maladies like heart disease and alcoholism. In addition, insurance companies might refuse to cover certain inherited health problems, declaring them preexisting conditions, or charge exorbitant premiums. Employers could discriminate against job candidates whose genes make them candidates for diseases that might mean higher insurance premiums or extra sick days.

Easy access to genetic information could also limit individuals' reproductive choices. Those carrying genetic traits deemed undesirable might even find themselves placed in "genetic quarantine" and prevented from reproducing either through social stigma or outright sterilization. Fetuses determined not to meet minimal standards could also be destroyed or altered through recombinant DNA technology. "Unless we're careful, we may see entire populations artificially altered by families and the state," warns Troy Duster, a sociologist and author of *Back Door to Eugenics*.

Despite the risks, of course, gene therapy promises substantial benefits. "Doctors intervene in the natural course of diseases all the time," says neuropsychologist Nancy Wexler, who chairs the HGI's Ethical and Social Issues Working Group. "Gene replacement therapy is actually a holistic kind of medicine because the doctors are using nature's own remedies, the healthy genes, to help the patient."

Yet whether genetic research fulfills its proponents' highest aspirations social protections must be implemented. Says Thomas, "We've got to establish responsible guidelines for these potent genetic techniques."

LISTEN TO YOUR HEAD.

SONY

TOOLS

FOR THE 21st CENTURY.
Owning the sky, hoodwinking the law, and hearing the birds

By Sandy Fritz

GUNSHIP 2000

MicroProse Software, 180 Lakefront Drive, Hunt Valley, MD 21030 $69.95
PLUSES: Accurate simulation, lots of helicopters.
MINUSES: Awfully violent.
VERDICT: Start your copters.

Gunship 2000 updates the classic combat helicopter simulation, providing more birds, more ordnance, more detailed scenarios. Graphics and sound have gotten a boost, delivering the feel of piloting a helicopter.

You're given the tools to handle incoming threats and accomplish your missions. A detailed manual helps you to learn your crafts' capabilities, and a nice replay feature lets you see the mission after you've flown it. Some of the missions, incidentally, bear more than passing resemblance to recent events in the Persian Gulf. For a wild first-class ride into deadly situations, look no further than *Gunship 2000*.

MORE FUTURE STUFF

Malcolm Abrams & Harriet Bernstein. Penguin Books, 1991. $10.95
PLUSES: Products from the near future.
MINUSES: Ugly book design.
VERDICT: Something for everybody.

I couldn't help but notice that several of the entries in *More Future Stuff* would be old hat to *Omni* readers, including blue roses, computerized shrinks, and refrigeration by sound. Obviously the authors have good taste.

Much of the future stuff is materializing even as you read: voice-activated microwave ovens, undersea walkie-talkies, "sun alert" watches mated to ultraviolet sensors. Fun contraptions, but the authors' naive reporting, combined with a truly irritating book design, threatens to derail serious browsers.

A SPEEDER'S GUIDE TO AVOIDING TICKETS

Sergeant James M. Eagan, NYSP (Ret.). Avon Books, 1991. $4.99
PLUSES: The precocious title says it all.
MINUSES: Could be condensed into a leaflet.
VERDICT: A must-read for chronic leadfoots.

This book tells you how to speed and how to avoid getting a ticket if caught. How many books can claim such utility?

Eagan says cops are terrified of being shot when they pull a speeder over. Your job: Make the cop feel safe (no sudden movements) and feed his ego—in under 30 seconds. Try flattery: "That's a noble mustache, officer." Another good tactic: the Potty Ploy. "Officer, before you write that ticket, could you follow me to a rest stop? I need to use a bathroom *immediately*."

KNOW YOUR BIRD SOUNDS

Cassette tape and booklet. Lang Elliott. Chelsea Green Publishing, Rt. 113, P.O. Box 130, Post Mills, VT 05058. 1991. $12.95

PLUSES: Learn the language of birds.
MINUSES: Requires an illustrated field guide (not included).
VERDICT: An eccentric, refreshing diversion.

If you enjoy an intellectual challenge, try mastering the language of birds. Discerning the subtle differences between species could take a lifetime.

Volume one covers yard, garden, and city birds; volume two isolates the calls of country birds. Even a casual listen will enable you to tell the difference between a cheerfully singing bird and an alarmed one. But to go deeper, you'll need field glasses, a detailed guide book, and patience. Hearing a call in the wild and then finding it on the tapes requires an aural memory rare in human beings. ☐

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*Letterbox

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WHEELS

INTELLIGENT HIGHWAYS

Electronic road maps, hand-held navigators, and automatic toll collectors

By Jeffrey Zygmont

James Costantino relates how he recently spent two hours traveling eight miles to his office in downtown Washington, an average speed of four miles per hour. Considering that a camel caravan travels at eight, he says "they moved twice as fast 7000 years ago as I move now."

Experts cheer the coming of choreographed, intelligent vehicle and highway systems in which cars communicate with computerized traffic controllers that steer them away from jams and accidents.

Today, traffic congestion is too great a problem to ignore, he warns. Costantino is executive director of IVHS America (Intelligent Vehicle Highway Systems), a nonprofit group formed in August 1990 at the request of the Department of Transportation mainly to coordinate the many traffic control programs.

IVHS America, a public-private partnership of more than 300 members including state and federal agencies and car and electronic companies, oversees a dizzying array of technologies. They include Advanced Transportation Management Systems, which monitor traffic and try to ease congestion, and Advanced Traveler Information Systems, which utilize dashboard mounted navigators like TravelPilot. Eventually they'll communicate with traffic management systems to guide drivers away from heavy congestion.

Maybe 20 years hence there will be Advanced Vehicle Control Systems. These will be automatic chauffeurs that take complete control of a car on freeways equipped with tracking sensors, allowing it to join a platoon of like-equipped cars traveling together at high speed while their drivers read the comics or snooze.

Costantino says it will take maybe $35 to $40 billion over the next 20 years to develop and test these technologies and maybe as much as $250 billion to build the systems.

So far, federal support seems assured, especially as the U.S. competes with programs in Europe and Japan. The European and Japanese systems that advise and direct drivers are advanced enough to be put into widespread use once squabbles over issues like standards for national and international uniformity are resolved.

Advocates say the first elements of smart highways are already in use in the U.S., pointing to such systems as the automatic toll collectors being tested in Oklahoma and Florida. They identify an individual car by reading an ID number transmitted via radio, automatically deducting toll from the driver's account.

Eventually, a computer navigator in each car will communicate with a computerized traffic central to help people get around. This system is still in the test and demonstration stages. Before it can be used, the federal government must set standards that will allow all the various pieces of equipment to work together harmoniously. Then comes the task of installing the systems' public portions—sensors and monitors to report on traffic conditions, computers to process the information, broadcast systems to distribute it.

In the meantime, private industry must develop lower cost equipment for cars. Motorola is close. So is GM, which expects navigator sales to take off when these back-seat drivers drop to the price of an auto air conditioner or radio—maybe $600 to $700. Optimists say all this may happen by the middle of the decade. The IVHS experts push it closer to 2010. Stan Honey says, "It could happen sooner than the IVHS community thinks."

Honey is the pioneer in street navigation who founded Etak, based in Menlo Park, California, in 1983. Etak now provides digital map data bases for traveler information and transportation management systems to the Japanese. Honey says that companies in Japan are developing hand-held navigators that could guide travelers to their destinations. Traffic information could be broadcast over private networks.

"I wish the IVHS community was more familiar with today's systems," he says. Rather than reinventing such devices as electronic road maps that guide drivers through unfamiliar territory, Honey argues that official efforts in intelligent vehicle highway systems should build on technology that already exists and set up the guidelines that would let companies really start selling the stuff. ☐

EARTH

LESSONS FROM THE THIRD WORLD
Sometimes the simplest ideas turn out to be the best ones

By Ben Barber

There were 15 minutes left before the train from Bombay to Delhi was to leave so I decided to buy a cup of "cha," sweet, milky Indian tea I gulped the brew served in a brown clay cup in order to return the container before catching the train Looking around, however, I noticed other customers simply dashing their empty cups to the ground where they were quickly crushed into the red-brown earth by the throngs These were disposable cups—Indian style

A month later, I bought coffee to go at Washington DC's Union Station It came in a plastic foam cup that will take hundreds of years to decompose in a landfill, all the while giving off ozone-destroying chemicals After I drank the coffee I tossed the cup into a plastic trash bag to join a growing collection of serving items destined for the dump

I wondered, how could we make the technology flow—typically from West to East—a more even exchange, with the planet as beneficiary? Would my children one day buy drinks sweets, or even compact discs in packages made from leaves bamboo, or other materials that decay into a rich compost? "There s a big question as to what is adaptable from the Third World,' remarks researcher John Young of the Worldwatch Institute ' Much of it takes low wages and a need for materials to justify Sometimes you can extract a kernel of Third World wisdom "

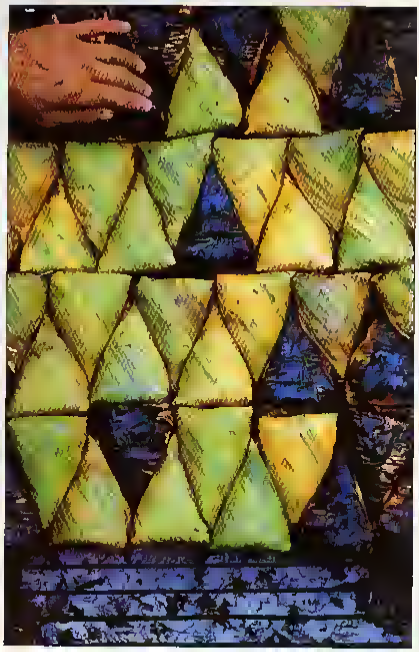
Already some McDonald's franchises have cut down on foam packaging Paper cups are making a comeback, and many cities are introducing recycling for newspapers plastic, aluminum, and glass Though these may not look like it, Young says they are Third World solutions to ecological problems

While most of us pay high prices for tasteless vegetables trucked from one coast to the other, the Chinese city of Shanghai produces all of its own vegetables, fertilizing them with human waste and exports a surplus In a similar vein, Washington, DC, has begun packaging sewage sludge for lawn fertilizer

Still, our ingrained garbage habits will die hard "It's a mindset a mentality " says Steve Hirsch of Volunteers in Technical Assistance ' Every time I go to a garage sale, I see people throwing away things that are considered gold in developing countries ' Recently in Marrakesh Morocco, Hirsch says he lost the key to his bicycle lock and visited a locksmith to have the lock cut away from the chain Instead, the locksmith drilled four small holes removed the lock s innards, made a new key, and reassembled the lock in about ten minutes "Where could you have done that in America? ' asks Hirsch

In fact technology these days flows almost exclusively from the West to developing countries satellites miracle rice bypass surgery and plastic bags Yet India, Africa, China, and Latin America remain storehouses of knowledge that might help save the planet from the glut of its own garbage

Each time I throw a plastic plate in the trash, I remember how I tossed the banana leaf from which I had eaten my rice to the ground in Madras, India and saw it immediately chewed up by a gentle cow And I remember the Artibonite Valley of Haiti where not a speck of plastic, metal, or glass spoils the earthen paths fields, and courtyards



Learning from our neighbors: Could the old-fashioned, ecologically correct ways of different cultures see a wider application?

So far I am aware of no systematic search for appropriate cost-effective Third World ideas that can be adapted in the West to preserve the planet But as the barges loaded with garbage find fewer places to dump their loads, some of the oldest ideas on earth may turn out to be the most important

GAMES

BEST BETS FOR FUN SEEKERS:
The top games range from cards to kinetic sculpture

By Scot Morris

Our choices of the best new games and products are listed not by preference but by suggested retail price

Set (Set Inc , 301 Cowley, East Lansing, MI 48823 $11.95) Children often beat adults and girls often beat boys at this "family game of visual perception " Not since *Pictionary* has a game appealed to such diverse age groups

Set contains a deck of

eighty-one cards, each with four pieces of information—symbol (diamond, oval, or squiggle), number (one, two, or three shapes), color (red, green, or purple), and density (open, solid, or shaded) Deal twelve cards faceup on the table and look for three-card "sets " They can all be green diamonds with one of them open, another solid, and the third striped for example Or they can all be different—for example, one open green diamond, two solid red ovals and three striped purple squiggles For any two cards in the deck, only one other card will complete the set The game can be played solitaire or by any number of players, all trying to be the first to shout, "Set!"

The Spiral Stair Puzzle (Architest 2269 Chestnut Street, #350, San Francisco, CA 94123, $30) Can you solve this intriguing puzzle even when given full instructions to build the spiral staircase from eighty maplewood pieces around a central newel post? Careful planning, a steady hand, and a generous supply of patience definitely pay off Along the way, learn some basic engineering—the running bond course, step and cantilever—and an appreciation of this ancient architectural discovery

Master Labyrinth (International Playthings, $34) Two to four players must move their pieces through corridors in this science-fiction art board game, racing to pick up (in numerical order) twenty-one ingredients required for casting a magic spell The corridors shift on each turn so a path that is open on one turn may be closed on the next Careful planning will open a path for you and close it for others If you don't look ahead, you'll find yourself stranded in a cul-de-sac away from all the goodies

Pyramis (Abalone $35) A strategy and visualization game for two players, *Pyramis* is a simple, original idea The rules can be learned in seconds but the strategy is far from trivial

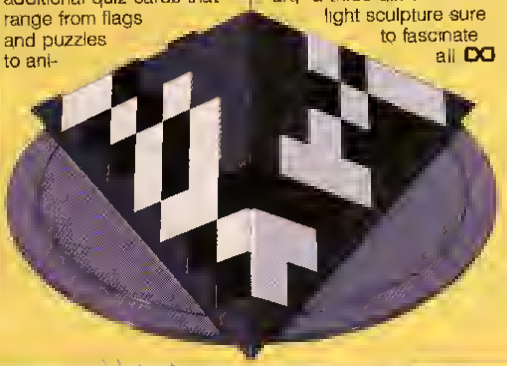
The board is a three-sided pyramid that rotates so players can see all sides You can place a tile on any side of the board, but gravity demands that the tiles be built up the side from the bottom of the pyramid The object is to join exactly five of your pieces—and no more—at their sides And patterns may continue around the edge of the pyramid to the next side

GeoSafari (Educational Insights, $99 95) Can you find Mount Vesuvius, Lake Victoria the Atlas Mountains, and the Gobi Desert on the world map? Marketed as an electronic geography learning game for kids *GeoSafari* can challenge inquisitive minds of any age A handicapping system allows separate time limits for answering so that, for example, a child might get a minute to answer while an adult will get only fifteen seconds

You can also order additional quiz cards that range from flags and puzzles to animals and languages And blank cards allow you to create lessons for your own neighborhood or places spotlighted in the news

String Ray (With Design In Mind, $129 95) Created by a London artist who wanted an interactive kinetic sculpture, *String Ray* consists of an ordinary string stretched between two rotating motors at the ends of two "rabbit ear" antennas When turned on, the

string vibrates and assumes all kinds of beautiful forms, from pure sinusoidal waves to chaotic patterns An adjustable strobe light adds a rainbow of color *String Ray* is beautiful "scientific art," a three-dimensional light sculpture sure to fascinate all



POLITICAL SCIENCE

CRISIS IN THE EMERGENCY ROOM

Trauma care units are in shock, but you may be the next casualty

By Tom Dworetzky

In Dallas, just another typical night at Parkland Hospital's trauma center: three dozen cases on the floor—a full house. There's an innocent civilian caught by a stray bullet during a drive-by shooting, a driver crunched in a pileup on the interstate. When the radio warns that yet another hemorrhaging individual is en route, the people at Parkland wave the ambulance off to another hospital farther away. "Trauma sat," is how they put it—for trauma unit saturated. Tough luck. The delay costs a life.

GOTTFRIED HELNWEIN

Trauma is an equal opportunity tragedy. But hospitals everywhere are being forced to close their trauma centers.

This type of situation has racheted trauma care to crisis proportions in cities around the country. Trauma units everywhere are overcrowded as never before. This full house is not, however, a boon to hospitals. Parkland, a public facility, expects to lose $23 million this year in unreimbursed expenses thanks to trauma care, which can run up to a half a million dollars per patient. Overall, trauma care is running nearly a $300 million a year in uncompensated funds in Texas alone. Private hospitals, unable to take these losses, are being forced to close their trauma units. Domino effect! Closings push more of the load onto the remaining trauma centers—driving them deeper into debt and forcing more hospitals to close their units. "You may not think this is important to you," says Parkland's president and CEO, Dr. Ron Anderson. "But trauma is an equal opportunity tragedy. It doesn't matter what your life-style or health insurance is like." About 140,000 Americans die each year from these severe injuries, and trauma is the leading killer of people under age forty-five in this country.

A recent study conducted by the General Accounting Office determined that there are other impacts of this crisis that affect all patients in a hospital. Besides the uncompensated trauma unit care that must be passed on as increased prices to other patients, there's also the disruption of operating room schedules and physicians which affects patients slated for surgery. There's also the fear physicians feel at the possibility of getting sued by the trauma patients they care for, with whom they have no prior patient-doctor relationship. Lastly, there's the unfortunate reality that trauma units are where victims of many societal ills wind up. In the crowded halls are the fallen in our losing battle with drugs, the increased use of assault weapons, rising crime. All have combined to shift the nature of trauma care from blunt injury (such as car crashes) to penetrating injury (knives and bullets). At Parkland in the past, blunt injuries led with about 70 percent. Now, shockingly, penetrating injuries make up 70 percent.

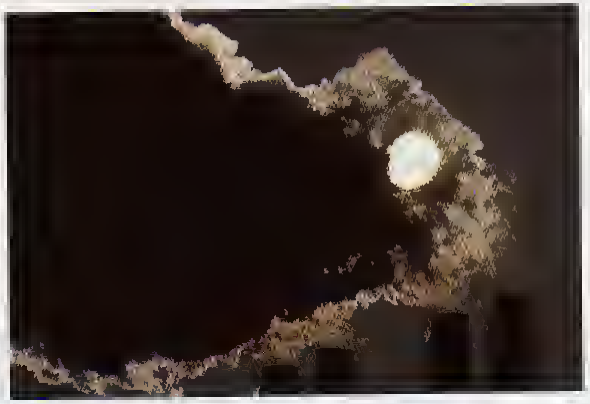
The difference that prompt trauma care can make is so profound doctors call the first sixty minutes after injury the golden hour. Studies show that mortality can be reduced by as much as 70 percent if intervention takes place within the golden hour. It can drop as low as 30 percent if treatment is delayed four hours in severe cases in which shock is a factor. "That's why trauma care is worth paying for, like a public utility," says Anderson.

What's to be done? One suggestion, according to Anderson, is to finance trauma centers with taxes on the instruments most likely to cause trauma: cars, guns, and ammunition. The cost would be small for the individual. The deficit that Texas runs could be covered almost completely by a $15 tax on auto registration alone. And the benefit is as clear as car insurance. You may never wreck your car, but would you drive around without coverage? Maybe you'll never need a trauma center, either, but do you really want to risk the possibility that none will be around if you do?

CONTINUUM

ENVIRONMENTAL REPORT CARD

What's your take on the air we breath, the water we drink, overflowing landfills, big holes in the sky, and other pollutants?



Last spring, an armada of jets from the four corners of the globe landed in the ancient port of Rotterdam, in the Netherlands, offloading an exotic array of cargo. Top level executives from the world's largest and most influential corporations, including Alcoa, Exxon, Union Carbide, and AT&T, converged to achieve a unique objective. Over 750 delegates convened at the second World Industry Conference on Environmental Management (WICEM) organized by the International Chamber of Commerce in cooperation with the United Nations to exchange insights and ideas regarding the future of planet Earth.

The very fact that CEOs and VPs represented their companies clearly shows that in the nineties big business considers the environment an important issue. Helmut Sihler, conference chair and head of Germany's Henkel Corporation, advocated "environmental audits"—similar to the traditional economic audit but instead tracking a company's ecological performance on an annual basis. William Ruckelshaus, chairman of Browning-Ferris Industries (and former head of the Environmental Protection Agency) proposed worldwide access to information on "green" policies and products and an aggressive program to inform the public about corporate environmental performance.

The world's corporate head honchos shuttled between seminars expostulating the joys of environmental management and promulgating the notion that businesses work with governments and environmental groups. At WICEM, there was not a shadow of a doubt as to whether or not a company should clean up one's own bailiwick. Savvy corporations understand that to operate competitively, they must operate clean. To insure that this credo becomes orthodoxy throughout the world, CEOs debate the concept of sustainable development. Big businesses have studied the demographics as assiduously as anyone and know that the world's population is expected to double in the next 38 years. Conferees devoutly believe that if a decent standard of living is to be available to the world's next generations, industry must devise ways to insure this by providing medicines, potable water, housing, transportation and communications for the world's new inhabitants. At the same time, industry must devise ways to provide these essentials for twice again as many people without destroying rain forests, poisoning rivers and oceans, expending all reserves of fossil fuels, or destroying the Earth's protective ozone layer. These are the cardinal principles of sustainable development, according to the Final Declaration of the Second World Industry Conference on Environmental Management, which enjoins industry to employ its "technical competence to solve many of today's environmental threats and preempt tomorrow's."

What can industry do? Integrate environmental criteria into economic practice, provide managerial, technical, and financial resources to tackle environmental problems, analyze the environmental impact of any new product during its entire life cycle—from raw materials to disposal or recycling, improve energy efficency, apply First World environmental standards to Third World factories, and extend economic and technical assistance to developing nations to help them develop ecologically sound practices.

In order to adhere to the demands of sustainable development, corporations can no longer "export pollution" to countries whose desire for development translates into lax environmental regulation. In his closing remarks to his colleagues assembled at WICEM, E.S. Woolard Jr., chairman of Du Pont, said, "When the history of environmentalism in the last quarter of this century is written, sustainable development may prove to be the major conceptual advance to have taken place during that period. We should be encouraged that industry has demonstrated an ability to think creatively about the environment, to think across industry lines and national boundaries, and to think not only of the needs of industrialized nations, but of the whole world."

—MELANIE MENAGH

CONTINUUM

PUTTING NUCLEAR WASTE IN ITS PLACE

Some 4.7 million cubic meters of nuclear waste have accumulated in the United States since the Manhattan Project in 1942, and the radioactive piles of debris—generated by the military as well as 112 operating nuclear power plants—grow by 100,000 cubic meters every year.

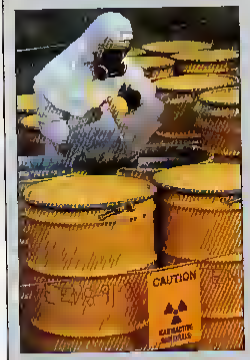
Currently, most of the waste material is sealed in steel drums and tanks and buried 30 to 40 feet deep in unlined trenches at federal sites in South Carolina, Washington State and Nevada. But these waste dumps are steadily filling up while the nuclear industry and a host of federal, state, and local agencies try to choose between several controversial contenders for a more permanent storage site, including Carlsbad Caverns in New Mexico and Yucca Mountain in Nevada.

An impressive array of technologies offers hope for cleaning up the radioactive mess by the target date of 2019. Of these possibilities, the most promising may be vitrification, according to James Buelt, a researcher at Battelle Memorial Institute's Pacific Northwest Laboratory in Richland, Washington.

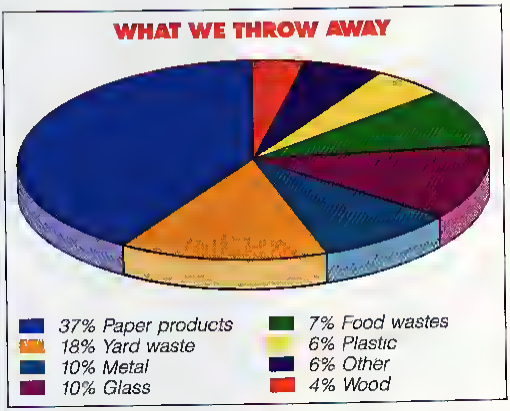
Inserting electrodes into contaminated soil, vitrification subjects low-level waste like cesium and strontium to 615,000 kilowatt hours of electricity and temperatures of 3,000°F. The technique turned one test area into a 900-ton block of leach-proof, glass-like material.

Plasma technology, another contender, superheats waste with a flame hotter than 18,000°F. It decreases the volume of contaminated metal-reactor hardware by a factor of 4, reducing it to metal ingots.

Yet another technique, bioremediation, stabilizes radioactive soil and groundwater through naturally occurring microbes that use nutrients to immobilize radionuclides. Still more exotic—and perhaps too expensive—is transmutation, which puts long-lived hazardous components of spent fuel back into a reactor core and then uses fission to break the components down into elements with half-lives of perhaps 300 years, far shorter than their normal lifespans.—George Nobbe



Underground radioactivity. Workers prepare waste for burial.



NO ROOM AT THE LANDFILL

Remember the *Mobro*, the huge, trash-laden platform that headed out from Islip, New York, in search of a landfill and returned months later because no one would accept it? It looks like the *Mobro* will be a symbol for the Nineties.

Landfills are closing at a frightening rate. According to the Environmental Protection Agency (EPA), the United States had 20,000 landfills in 1978. By 1988 that number had dropped below 7000. During the same interval, the country's volume of municipal waste increased from 150 million tons to 180 million tons. Each person in the United States now throws away an average of 3.5 pounds of solid waste a day.

Today, 16 states have less than five years of landfill capacity left, says Allen Blakey of the National Solid Wastes Management Association. Cities are in trouble, too. Chicago will run out of space by 1994, Los Angeles by 1995. Community resistance has made new dumps nearly impossible to site.

EPA safety regulations passed in September will also add to the expense of building a facility. They require that new landfills have liners, wells to detect groundwater contamination, monitors to detect methane, and a means for monitoring leachate for 30 years after the site closes.

More aggressive recycling can reduce the volume of waste, and some environmental groups are calling on manufacturers to cut the amount of packaging they use. But fundamentally, American consumers just buy too much and throw it away. To help combat this problem, environmentalists encourage a vigilant approach—"precycling." Given the choice of two roughly equivalent products, they say, buy the one with less packaging.—Mark Fischetti

WHAT'S COMING OUT OF YOUR FAUCET?

Six years ago, Congress told the Environmental Protection Agency (EPA) to regulate 83 of the nation's worst drinking water contaminants, following up the Safe Drinking Water Act passed nearly 20 years ago So far the agency has established legal health limits and set safety standards for about 60 of the contaminants, including vinyl chloride, a probable carcinogen. Does this mean America's tap water has improved?

"It's hard to say if the water has gotten better or worse," says EPA water officer Maria Gomez Taylor. "But we do have more standards. The number has doubled in the last five years."

The EPA and the state authorities lack the funds and personnel to enforce those standards adequately. Between 1986 and 1988, the Centers for Disease Control tallied 26,000 cases of waterborne illness, possibly only a fraction of the real total. Today, the EPA estimates one in six Americans drinks lead-contaminated water, and a recent survey discovered nitrate in more than half the drinking wells tested. Chlorine is routinely used to disinfect municipal water supplies, although under certain conditions it can combine with organic matter to produce poisons. Seven out of ten Americans regularly drink chlorinated water, which may double the risk of acquiring bladder cancer.

In an effort to eradicate tainted tap water once and for all, some experts now advocate new disinfectants rather than new standards. But these alternatives may produce as-yet-unknown health problems of their own.

And while water disinfectants are a major problem, "99 percent of harmful chemicals in drinking water are there through the careless disposal of industrial and household waste," says Washington State University drinking-water expert Richard Bull.

—Scott Fierman

Half full or half empty? The U.S. government has passed drinking-water standards galore but lacks the resources to enforce them

Lakes and buildings as well as trees feel acid rain's sting

WHO'LL STOP THE RAIN?

In the Seventies, scientists began to discover that lakes from New York to Sweden had become vinegary, acidic pools devoid of fish, frogs, turtles, snakes and plants. They blamed the damage on acid rain, a phenomenon caused by sulfur dioxide and nitrogen oxides emitted by power plants, factories, and cars, the two gases combine with water in the atmosphere to produce sulfuric acid and nitric acid that fall as rain. Despite squabbles over the cost, the 1970 Clean Air Act and subsequent amendments went a long way toward cleaning up industrial emissions. But they failed to neutralize the rain.

From 1970 to 1988 man-made emissions of sulfur dioxide in the United States decreased between 28 percent and 30 percent, according to the U.S. National Acid Precipitation Assessment Program (NAPAP). The 1990 amendments to the act mandate that by the year 2000 such emissions be reduced to 50 percent of 1980 levels.

Sadly, the acid rain keeps on falling. "Acidity in rain does not seem to go down," says Patricia Irving, NAPAP director.

It seems scrubbers installed to remove fly ash from smokestacks also removed the alkaline calcium that used to help neutralize acid rain. In addition, the country has paved so many dirt roads and changed its agricultural practices so much that it produces less neutralizing limestone dust.

Acid rain leaves agriculture largely untouched but it devastates buildings, some forests, and cultural items, such as the stone lions at the New York Public Library.

The residual effects of acidification on lakes and streams will probably linger for decades, even when the provisions of the 1990 Clean Air Act gradually cut acid rain. "In sensitive areas like the Adirondacks," where soils are thin and lack alkaline material, "we project only 8 percent of the lakes will improve in the next 50 years," Irving says.

—Ben Barber

CONTINUUM

Smog gets in your eyes. Maybe it doesn't look like it, but Los Angeles air is cleaner than it's been in 40 years.

AIR FIT TO BREATHE

Decades ago, comedians quipped that in Los Angeles you woke up to the coughing of the birds. These days, the birds and the comedians have changed their tune.

"Our air is cleaner than ever," says Tom Eichhorn, spokesman for the South Coast Air Quality Management District that encompasses the Los Angeles area. "In 1955 our ozone levels hit 68 parts per million. In the last three years it has not exceeded 35 parts per million. We cut pollution in half during a period when population more than doubled and cars increased from 2.3 to 9 million."

Nevertheless, the levels of smog in Los Angeles air still exceeded federal standards of .12 parts per million of ozone on 130 days in 1990. By comparison, New York City, the next worst city, violated Federal standards an average of 17 days a year from 1987 to 1989. Still, just 14 years ago, Los Angeles smog levels exceeded federal standards on 208 days, making the recent drop a major improvement.

Air-quality officials attribute the cleaner air to stringent state standards for auto emissions, which forced automakers to build special, cleaner cars to be sold in California.

Smog forms when sunlight hits hydrocarbons and nitrogen oxides emitted by various sources. Cars account for about 50 percent of the troublesome pollutants, industry contributes another 25 percent, and consumer products, including paint and hair spray, supply the rest.

To sense how much Los Angeles' air has improved, sniff the fumes at Mexico City, says Mary Nichols of the Natural Resources Defense Council. "They have only one third the cars we do but exceed ozone standards 70 percent of the time."

—Ben Barber

NO SHORTAGE OF OIL AT PRINCE WILLIAM SOUND

To a visitor, Prince William Sound off Alaska seems a symphony of snow-capped peaks and rocky beaches. But the mussels are laden with hydrocarbons, sea otters sicken and die, and the bald eagles that survive may well carry the ticking time bomb of reproductive damage.

These are a few of the long-term effects of the massive spill of 11 million gallons of crude oil from the Exxon tanker *Valdez* on March 24, 1989, in pristine Prince William Sound. While most of the oil evaporated, broke down, or was cleaned up, much remains in the subsurface of the beaches and in ocean-floor sediment. It continues to damage the sea grasses and to enter the food chain through the shellfish that otters and other animals eat. Even the well-intentioned efforts to clean the water with chemicals and the beaches with hot water have left damage, destroying microorganisms at the bottom of the food chain.

"It's impossible to say how long before the area returns to normal," says Robert Adler, a lawyer with the Natural Resources Defense Council.

Some 350,000 to 500,000 birds died in the spill, and many more had their breeding disrupted. Although 144 of the 2,200 bald eagles in the area were found dead, the toll is likely several times higher. Eighty-five percent of the eggs laid near heavily oiled beaches have failed to hatch.

Salmon eggs exposed to oil in 1989 showed 70 percent greater mortality, and larvae from heavily oiled streams had club fins and other abnormalities.

The damage to wildlife left the greatest impact on the Native American residents of 15 Alutiiq villages. They had to completely halt their subsistence food gathering and hunting in 1989 and have only gradually begun to resume their life-style.

—Ben Barber

Oil and wildlife don't mix, as the 1989 Exxon oil spill off Alaska's pristine Prince William Sound proved.

CONTINUUM

Ozone maps reveal that the North Pole s ozone is vanishing.

THE HOLE TRUTN

The sky may not be falling, as Chicken Little once feared, but part of it is disappearing Satellite records since 1978 show that ozone—a rare form of oxygen found in the upper atmosphere, some 9 to 30 miles above the earth's surface, that protects us from the sun's ultraviolet radiation—is vanishing. By 1985 scientists realized that a "hole" roughly twice the size of Antarctica had formed in the ozone layer above that continent. Now, during the months of September and October, about two thirds of the ozone that once shielded Antarctica disappears

Aircraft experiments proved that chlorofluorocar bons (CFCs)—substances used in spray cans, air conditioners, and refrigerators—are the primary cause of the Antarctic ozone hole CFCs gradually release chlorine atoms, which destroy ozone Subsequent experiments in the late Eighties revealed that an ozone hole may soon form over the North Pole as well, with some scientists predicting that more than 10 percent of the ozone there will vanish by decade s end Recent satellite data also indicate that ozone is disappearing from the Northern Hemisphere at twice the rate previously suspected.

Consequently the Environmental Protection Agency now predicts an additional 12 million skin cancer cases and 200,000 resultant deaths in the United States over the next 50 years.

In response to this threat, the industrial nations of the world have agreed to phase out production of CFCs and other ozone-depleting chemicals by the year 2000 developing countries have until 2010 to do the same Still, that some CFCs survive in the atmosphere for 75 to 125 years compounds this problem "Even if we don't add another ounce of chlorine to the atmosphere," says Mike Kurylo, NASA s manager for upper-air research "it will take about a century for ozone levels to return to their pre-1985 levels before the ozone hole occurred "

—Steve Nadis

EVERYTHING OLD IS NEW AGAIN

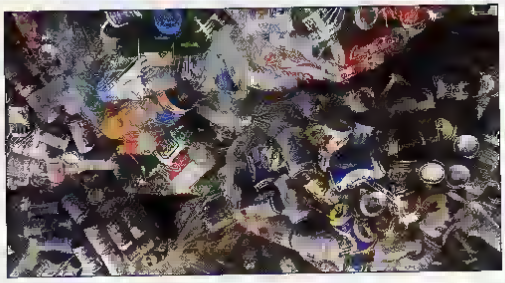
Recycling an afterthought as recently as the early Eighties has become second nature to many Americans Since 1986, 40 states have enacted legislation requiring communities to recycle parts of their waste

The effect has been dramatic In 1980 the nation recycled only 14 million tons of its municipal solid waste and burned virtually none to produce energy In 1988 24 million tons were recycled, and 26 million more were incinerated to produce electricity, according to Marge Franklin of Franklin Associates a consulting firm in Prairie Village Kansas.

Recycling of certain materials continues to increase steadily The country now recycles 55 percent of all aluminum cans Reuse of glass also continues to rise as does the composting of yard waste

But recycling has become an industry and thus subject to the vagaries of the marketplace While Americans recycle one quarter of the 67 million tons of paper consumed annually, the recycling industry probably couldn't handle the remaining three quarters even if people brought it in Because demand for recycled paper now roughly equals supply few recycling mills are being built, says Allen Blakey of the National Solid Wastes Management Association To increase demand, environmentalists want the federal government to begin procuring recycled paper

The paper recycling process has been refined so that it's inexpensive and efficient, but recycling plastic is expensive requires a lot of energy and generates pollution The furor over juice boxes epitomizes the plastic-recycling predicament Americans purchase more than four billion of the convenient little boxes each year and recycle almost none Made of laminated layers of paper, foil, and plastic, these so-called aseptic packages produce pulp of such a low grade that no one wants to buy it.



Endless recycle U S consumers turn in about 55 percent of all aluminum cans sold for recycling

Further improvement in recycling hinges on legislation including financial incentives For example the city of Seattle now charges residents for each can of garbage collected

—Mark Fischetti

KING ARTHUR'S EXCALIBUR

WROUGHT OF STAINLESS STEEL. ACCENTS OF 24 KARAT GOLD AND STERLING SILVER. HAND-SET CRYSTAL CABOCHONS. INSERTED IN CRYSTAL-CLEAR ROCK.

KING ARTHUR. Immortal hero of medieval legend, he was the only one who could free the magical Excalibur from stone. And when the most famous King of chronicle and romance wielded this mighty sword, he became invincible.

Now you may own the authorized re-creation. From Europe, its blade is wrought of tempered steel. Its pommel and crossguard sculptured with Arthur's symbol of power—the dragon. Ablaze with fiery red crystals and embellished with sterling silver and 24 karat gold electroplate, Excalibur is to be removed from its crystal-clear rock only by the man destined to possess it. $675.

RETURN ASSURANCE POLICY

If you wish to return any Franklin Mint purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

The magnificent hardwood-framed display—shown smaller than actual size of 51½" high x 16½" wide—is included at no additional charge.

Excalibur shown smaller than actual length of 43".

AN OFFICIAL ISSUE OF THE INTERNATIONAL ARTHURIAN SOCIETY

The International Arthurian Society
c/o The Franklin Mint
Franklin Center, Pennsylvania 19091

Please enter my order for the authorized re-creation of King Arthur's Excalibur sword. Crafted of hand-polished tempered steel and embellished with sterling silver and 24 karat gold electroplate. The custom-designed display is included at no additional cost.

I need SEND NO MONEY NOW. I will be billed in ten equal monthly installments of $67.50* each with my first payment due prior to shipment.

*Plus my state's sales tax.

Please mail by January 31, 1992.

SIGNATURE _____
ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

MR/MRS/MISS _____
PLEASE PRINT CLEARLY

ADDRESS _____ APT NO. _____

CITY/STATE/ZIP _____

85468-75

CONTINUUM

BY THE NOT-SO-BEAUTIFUL SEA

Once only driftwood, seaweed and shells washed up on America's beaches. Now, hypodermic needles, plastic bags and other potentially dangerous debris litter our shores. Despite widespread publicity, garbage continues to be dumped at sea.

In 1988 six East Coast states issued 475 ocean and bay beach closures and advisories due to high bacteria counts, reports the Natural Resources Defense Council (NRDC). By 1990 the number jumped to 1429.

"The problem does not appear to be getting better," says NRDC environmental engineer Diane Cameron.

The major culprit in bacterial pollution is sewage that mixes with storm water in Boston, New York and other cities. Heavy rains overflow sewage plants, spilling raw human waste into rivers and bays. Redesigning these sewage systems will take billions of dollars.

Garbage dumping, however, is easier to regulate and control. The Marine Pollution Treaty, signed by the United States in 1987, has outlawed dumping plastic and other trash at sea, but enforcement has been lax until recently, so "it's too soon to see the effects," says Jil Zilligen of the Center for Marine Conservation.

"Enforcement is needed—the Coast Guard is understaffed and underfunded," Zilligen says. She praises citizens who reported boats dumping trash, including passengers of cruise ships who blew the whistle on their captains.—Ben Barber

The plastic holder from the six-pack that you enjoyed last Saturday could kill a bird. Please remember to cut the rings.

I'M A LUMBERJACK AND I'M OK

For the most part, loggers replace the trees they cut.

After decades of public pressure and regulation, the U.S. logging industry has finally become at least somewhat environmentally responsible. American demand for wood continues to rise, yet the nation's forests are growing faster than they're being harvested.

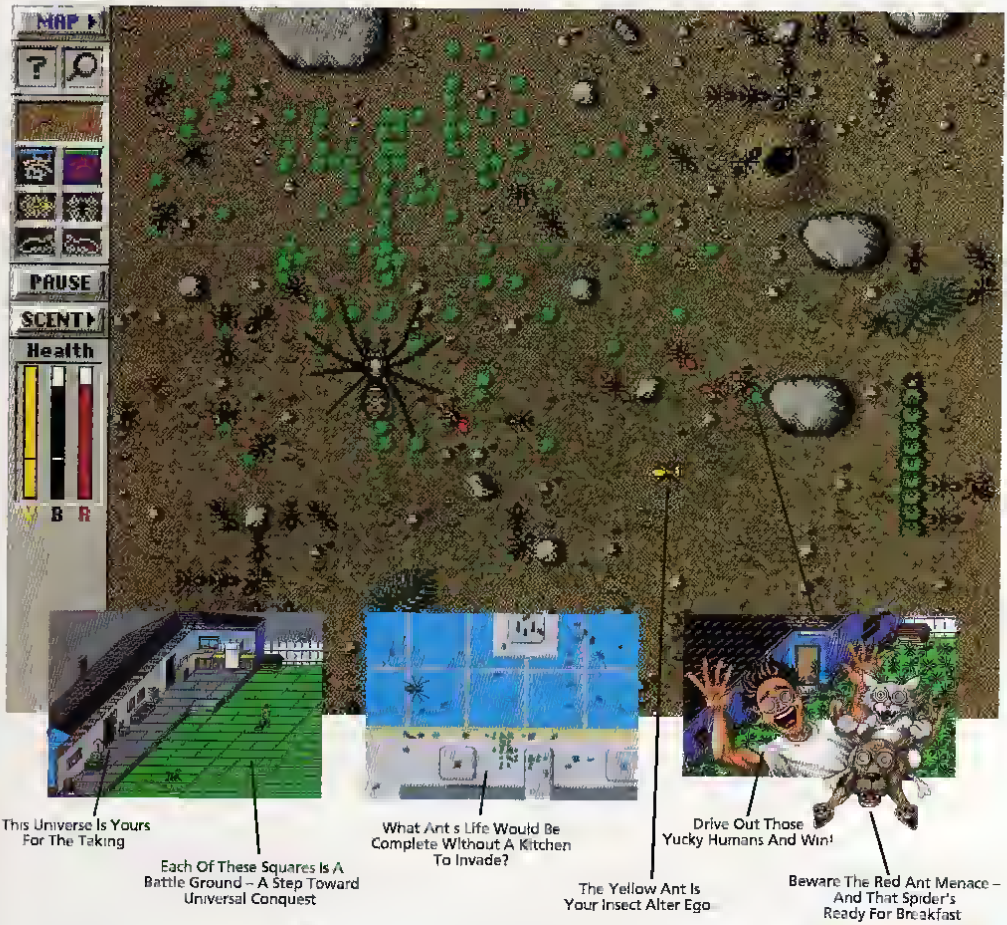
In 1990, logging companies planted some 1.9 billion seedlings, according to the American Forest Council (AFC), which represents the forest products industry. In recent years, the volume of new growth has increased faster than that being harvested. But potential problems remain.

Though growth outpaces harvest nationally, the two run about even in the Pacific Northwest, and logging there is accelerating faster than in any other region. Also, the timber industry still rails against legislative restrictions. "There are several hundred thousand acres in the Northwest we can't harvest because they are home to the spotted owl," protected by the Endangered Species Act, the AFC's John Heissenbuttel says. "And depending on how wetlands are defined in pending legislation, we may lose another 60 million acres nationally."

Significant amounts of logging in the West have taken place in that region's old-growth forests, which sustain a greater diversity of plant and animal life than younger trees. In addition, logging companies tend to plant more fast-growing trees, mostly softwoods like pine, to satisfy replanting regulations, this practice reduces the volume of desirable hardwoods like oak. To help, loggers have recently begun to pluck select trees from woodlands, which may not prove economical, says Gerry Gray of the American Forestry Association, a conservation group.

The most potent issue, however, is regulation of private land. About 57 percent of the country's forests are privately owned, according to the National Forest Service. State governments regulate private lands, and their record is spotty. It's unclear how much replanting or management takes place at all in these vast areas. Whether the timber industry continues its relatively good record, Gray says, will rest largely on how aggres-

Walk An Inch In My Shoes



This Universe Is Yours For The Taking

Each Of These Squares Is A Battle Ground – A Step Toward Universal Conquest

What Ant s Life Would Be Complete Without A Kitchen To Invade?

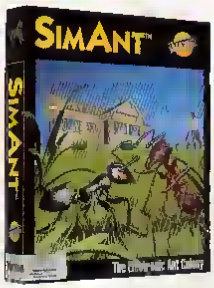
The Yellow Ant Is Your Insect Alter Ego

Drive Out Those Yucky Humans And Win!

Beware The Red Ant Menace – And That Spider's Ready For Breakfast

I'm an ant. You've stepped on me, poisoned me, cursed me—even held a magnifying glass over me. But do you know what it's like to be me?

SimAnt™ **The Electronic Ant Colony** puts you in my place. This new game from the creators of SimCity® and SimEarth™ lets you experience life as an ant. Fight for queen and colony. Face hungry spiders and menacing hordes of enemy ants. Endure abuse from those merciless humans. So easy to play even a human can do it — but, based on real ant biology and behavior, **SimAnt** has the depth of play and serious gaming challenge to really drive you buggy. So, before you step on another ant, walk an inch in my shoes. All six of them. SimAnt is available now at your favorite software retailer, or call MAXIS direct at **1-800-33-MAXIS**.



Macintosh and VGA screens shown. Available for Macintosh; DOS version available soon. SimAnt, SimCity and SimEarth are trademarks of MAXIS. ©1991 MAXIS. All rights reserved worldwide. And then some. OMN192

REPORT CARD ON THE ENVIRONMENT

(AND WHERE TO SEND IT)

If you agree with our grades, or care to add your own, please mail or fax this page, or a copy of it, to the person who can most easily put in motion the homework and longterm projects that might actually bring these grades up

Send this page to:
The Environmental President, George Bush
The White House
1600 Pennsylvania Ave
Washington, DC 20500

Or FAX it to:
The Environmental President, George Bush
(202) 456-2461

Dear Environmental President:

We regret to inform you that your grades on environmental issues are in need of improvement. The upcoming grading period—Election Year 1992—may prove crucial to your continued presence in office.

We look forward to your improved performance on these and other environmental issues.

Sincerely,

A Fellow Citizen of Our Beleaguered Planet

THE GRADES
AS DETERMINED BY *OMNI* MAGAZINE

		MY OWN OPINION
RECYCLING	**GRADE B**	
LANDFILLS	**GRADE D+**	
LOGGING	**GRADE C**	
OZONE HOLE	**GRADE D**	
AIR POLLUTION	**GRADE C**	
OCEAN DUMPING	**GRADE D-**	
DRINKING WATER	**GRADE D**	
PRINCE WILLIAM SOUND	**GRADE F**	
ACID RAIN	**GRADE C**	
NUCLEAR WASTE	**GRADE C-**	

(See the January 1992 *OMNI* for explanation of grades.)

Comments:

51 THINGS YOU MUST KNOW ABOUT SCIENCE, TECHNOLOGY, AND YOUR FUTURE

ARTICLE BY THE OMNI STAFF

At *OMNI*, we spend a good deal of time looking at science, technology, and the future, encountering far more ideas, innovations, and insights than we could ever cover in the pages of a monthly magazine. In discussions with scientists and readers of technology, wide reading, reflection, and conversations among ourselves, we arrived at this month's cover story—a casserole, if you will, of items we feel are interesting, imaginative, and important. Some we've covered in *OMNI* before, others may be new to you. Some are old, others lie on the cutting edge of speculation. If you'd like to see us cover any of these items in greater depth, please drop us a line.

BEGINNINGS

1

SCIENCE is the orderly arrangement of knowledge about the universe and its workings, derived from careful observation, recording, analysis, and repeated testing of conclusions.

2

TECHNOLOGY is science put to practical use.

3

THE AGE OF THE UNIVERSE. Most scientists today put the age of our universe at 10 to 20 billion years. However, some scientists split the difference and say the universe is 15 billion years old, based on evidence and research as well as supposition.

4

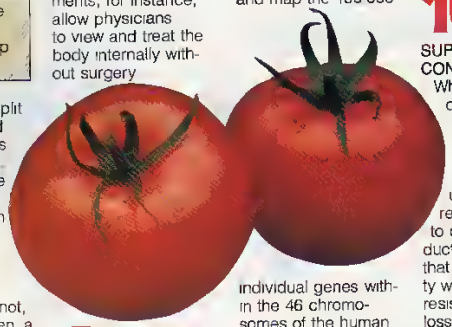
ASTROLOGY is not, and never has been, a science.

BIG SCIENCE, BIG TECHNOLOGY

5

FIBER OPTICS. More than 20 years ago Corning Glass Works introduced optical fibers—glass threads

smaller than a human hair—capable of carrying perhaps a thousand times the data carried through a traditional copper-cable telephone wire. Over the next few decades, as phone companies replace copper wire with fiber-optic cable, they will be able to offer film libraries and interactive information services. Fiber-optic technologies are revolutionizing medicine. Fiber optic instruments, for instance, allow physicians to view and treat the body internally without surgery.



6

TOP TOMATO. Athanasios Theologis and colleagues at the Plant Gene Expression Center in Albany, California, have built a top tomato. Their new plants, produced via genetic engineering, take more than twice as long to ripen as ordinary tomatoes. As a result, the tomatoes will stay fresh on long journeys across the country or even around the world.

7

NANOTECHNOLOGY TAKES JAPAN. The Japanese have a new rage: nanotechnology, where technology is built from molecular parts. Building machines that have working parts the size of molecules, scientists will eventually create ultrafast computers or tiny machines that can enter the body and deliver drugs or perform precise surgical functions.

8

HUMAN GENOME PROJECT. The mammoth effort to identify and map the 100,000 individual genes within the 46 chromosomes of the human body. Taking some $3 billion and 15 years to complete, the government-sponsored project may prove even more ambitious—and fruitful. Knowing the sequence of the 3 billion base pairs of the human genome DNA that contain our genetic heritage may one day allow researchers to diagnose and treat inherited disorders as well as currently incurable diseases such as cancer and AIDS.

9

PHARMACOWLOGY. We may soon be using bovine factories to manufacture drugs. Researchers from Britain's Agricultural and Food Research Council, and a company called Pharmaceutical Proteins, have shown that cows endowed with foreign genes can manufacture pharmaceuticals in their milk. When bovine drug "pharms" are working full force, they'll eliminate the need for expensive drug factories. What's more, the genetically engineered cows will reproduce themselves with each new generation.

10

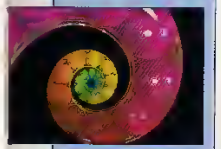
SUPER CONDUCTIVITY. What do high-speed computers and super-efficient power generation have in common? They are tantalizing products promised by researchers working to develop superconductors—materials that conduct electricity with almost no resistance and little loss of power. Until recently, the best superconductors required extremely cold temperatures. The discovery of high-temperature, ceramic-based superconductors in 1986, however, made the early promise of superconductivity a real possibility for these and many other applications.

11

EARTH: The earth, scientists generally agree, is about 4.6 billion years old, or 10 billion or so years younger than the universe.

12

CHAOS: Chaos challenges the deterministic notion, the bedrock of Western science, that one can predict future events by gathering enough information. Chaotic systems, however, appear to have an underlying, unexpected, order, when plotted graphically, they yield elegant geometric patterns. Scientists have taken



to the task of finding order in dynamic systems once believed to be random.

13

THE GENE RACE. On June 20, 1991, the National Institutes of Health presented biologist Craig Venter's voluminous application to the U.S. Patent Office. Venter's mission: patenting some 348 new human genes. As we usher in the new year, the U.S. Patent Office is holding its breath, expecting a gold gene rush of scientists arriving to patent every manner of human gene. But Maynard Olson, a Washington University geneticist and member of the Human Genome Project's advisory panel, thinks patenting human DNA is a philosophically iffy idea. "It's like patenting the periodic table," he says. Naked DNA sequences belong to all.

14

EARTHQUAKE PROTECTION. Using 'smart' technology, future builders will fashion structures able to shake off earthquakes by incorporating massive weights or braces that counteract the oscillations. Sensors will transmit information about seismic vibrations to a central computer that will tell the weights how to respond in order to stabilize the building. Before such buildings become commonplace, however, the world may experience disastrous tremors—some in our own backyards. An earthquake of magnitude 6 on the Richter scale, similar to the San Francisco quake of 1989, is likely to strike along the Midwest's New Madrid fault—site of a series of severe quakes in 1811—by the year 2000.

15

RAIN FOREST, INC. When it comes to saving the rain forest, multinational corporations are getting into the act. The giant pharmaceutical firm Merck & Company has decided to collaborate with scientists from Cornell University to collect samples of plant and invertebrate species in the Costa Rican forest. The hope is that some of the species will be used to make new drugs. Profits from the drugs, in turn, will be poured back into a fund for saving the rain forest.

WORRIES

16

DIET FOR A SMALL PLANET. As humans take up more and more space on the planet, we may have to come up with alternate ways of producing our food. One possible solution was recently suggested by an expert panel of the National Research Council. Instead of full-sized livestock, the panel suggested, we should turn to "microlivestock"—miniature versions of cattle, sheep, goats, and pigs, and other diminutive species, including the giant rat. "Like computers, livestock for use in developing countries should be getting smaller and becoming more 'personal,'" the NRC report said. "Conventional 'mainframes' such as cattle are too large for the world's poorest people, they require too much space and expense."

17

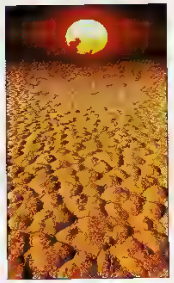
BIODIVERSITY Scattered among hundreds of thousands of plant species lies a wealth of genetic information Many of the species have never even been identified, much less studied Most of them never will be Selective breeding practices of modern agriculture and widespread deforestation are killing them off at breakneck speed With each dies a library of genetic information, possibly including the clues to kicking cancer or feeding a hungry world

18

LEAD ON ICE: Greenland's ice serves as an invaluable monitor of lead pollution Two decades ago, scientists found that lead concentration in Greenland's ice had increased about 200-fold since ancient times The pollution reflected the emissions of lead-based gasoline Based in part on this research governmental bodies around the world began limiting the amount of lead added to fuel It may work In a recent study of Greenland ice, lead concentration had decreased by a factor of 7.5

19

GREENHOUSE EFFECT During the summer drought of 1988, alarmed scientists sounded a dire warning The world is growing dangerously warmer, due to the greenhouse effect—



the process by which carbon dioxide and other gases from power plants and automobiles absorb the sun's infrared rays, much like the walls of a greenhouse The experts cautioned that rising temperatures from the buildup of fossil-fuel gases would in time flood coastal areas and turn cropland to wasteland A worldwide debate however is also warming up Other scientists have characterized the temperature increase as a typical climate shift

20

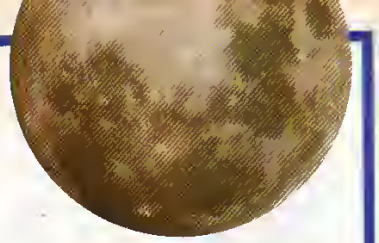
POPULATION EXPLOSION: The world presently supports more than 5 billion people Because population growth is exponential a staggering 10 billion people will share the planet's diminishing resources by the year 2025 Scientists are worried that food production or the earth's capacity to absorb waste may not keep up with demand Moreover, with widespread deforestation, the need for firewood, the Third World's principal fuel, will increasingly exceed sustainable yields Other forces may serve to curb the population crisis Science may develop ways to accelerate food production, and disease, already wreaking havoc in the Third World, is sure to devastate pockets of the earth's people

21

OZONE MADNESS: Stratospheric ozone levels over Antarctica have reached the lowest levels ever recorded, according to recent satellite reports In other words, that ozone hole is now immense Watch out for an increase in skin cancer worldwide

22

GAIA HYPOTHESIS In 1972, British scientist James Lovelock had a vision The earth was a giant living organism whose bodily functions were the atmosphere, the seas, life itself Calling his theory Gaia ('guy-ah') for the mother Earth goddess, Lovelock proposed that environment and life are two parts of a single system which interact in a self-regulating and self correcting way Critics say Gaia can't be proven and therefore is more akin to philosophy or religion, not science



QUESTIONS KIDS ASK

23

MOON IN MOTION The moon has earthquakes—or, more accurately, *moonquakes* Most of these very weak quakes are caused by tidal forces resulting from increases in the Earth's gravity as the moon moves closer to the Earth during part of its orbit Others most likely occur when molten or partly molten rock below the moon's surface shifts Moonquakes last longer than earthquakes—the landing of the Apollo 12 lunar module set the moon vibrating for more than two hours

24

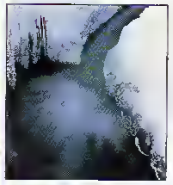
THUNDER: is caused by lightning, the two are inseparable A lightning bolt heats the air around it to 50,000°F, and this hot air does what every hot thing does—it expands This incredibly fast expansion produces a sound akin to a sonic boom

25

SKELETON BEACH That soft, white sand you curl your toes in when you go to the beach is not miniscule shavings of rock, as you might think Instead, it's the skeletons of ancient plants and animals Some of those organisms used calcium, either as part of their own skeletons or as a shelter Others were literally made of glass and absorbed silica, the main ingredient in glass, from sea water and ocean-floor clay Over the years, water and other organisms ground these plants and animals down into the granules of sand that form our beaches By the way, the grayish sand usually found elsewhere, like in your backyard, did indeed come from the erosion of rocks

26

DON'T SUCK Doctors now know that the time-honored advice for treating a snake bite—making an incision at the bite and sucking out the venom—doesn't really work and may do more harm than good The incision is prone to infection, and the suction method has been found to remove at best just 18 percent of the venom Also, doctors recommend trying to *slow* the circulation of blood with something like an Ace bandage rather than trying to *stop* it with ice or a tourniquet, the bitten area badly needs blood to reduce potential tissue damage And if the snake attacked in self-defense, the bite victim is better off than if it was looking for food, it injects more venom into its prey to paralyze or kill it quickly



27

ICE is denser than room-temperature water, and heat rises Sunlight should heat the surface of water faster than water at the bottom So why doesn't ice form on the bottom, instead of the top of bodies of water? It turns out that water reaches its greatest density *before* it freezes—at 39.2° F heit. It then expands as it freezes, so the water between 39.2° and 32° (the freezing point) is less dense and thus rises to the surface As water at the freezing point turns into ice, the various crystals bond together and expand, remaining on the surface because of their lower density

Hail to Thee, O Isaac Asimov!

How to pick the best out of Asimov's science books? Not easy But those of us who have read and loved Isaac's work have learned from him that the easy way is rarely the right or the best way.

Here's my pick of the 10 best of Isaac Asimov's science books.—Keith Ferrell

Asimov's New Guide To Science—Every home needs one *Asimov's Biographical Encyclopedia Of Science & Technology*—The women and men behind the history - *Asimov's Chronology Of Science & Discovery*—Who did what, and when. *The Human Body*—How we work *The Human Brain*—How we think. *Understanding Physics*—Hard science made simple. *Realm Of Numbers*—Trouble with arithmetic? Read this. *Essays*—*Any* of Isaac's collections of succint articles and essays. *Our Angry Planet*—Written with Frederik Pohl, this is an eloquent examination of the damage we're doing to our world *Atom*—A new book and a masterpiece.

28

SALT in the oceans comes from several sources minerals from eroded rocks that are carried into the ocean by rivers, volcanic rock, and basalt that erupts up from below the ocean floor The concentration of salt has remained stable at about 3.5 percent for about 1.5 billion years

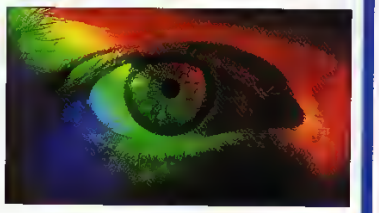
29

LIGHT WEIGHT. A square mile of sunlight weighs about three pounds Sunlight has weight because it exerts pressure on anything it encounters If all the sunlight reaching Earth could be weighed, it would tip the scales at more than 87,000 tons.

30

GALAXY IN MOTION: Like the planets, our galaxy, the Milky Way, revolves The galaxy takes its time to revolve 230 million years, known as one galactic year The Milky Way has only been around for about 52 galactic years, or 12 billion years Our sun, the earth, and the other planets trek over a million trillion miles each galactic year

GRAY MATTERS



31

CONNECTED There are 200 billion neurons in the brain, 10 to 50 times that many glial, nutritional, and "support" cells, millions of trillions of connections between these cells.

32

ON THE SURFACE: The surface area of the human cerebral cortex is 10 times as great as a monkey's, 1000 times as great as a rat's

33

ACME CELLS: One typical neuron, a pyramidal cell, has up to 100,000 specific connections to other cells "The pyramidal cell is the acme of biochemical evolution."—Dominick Purpura, Dean, Albert Einstein College of Medicine, New York

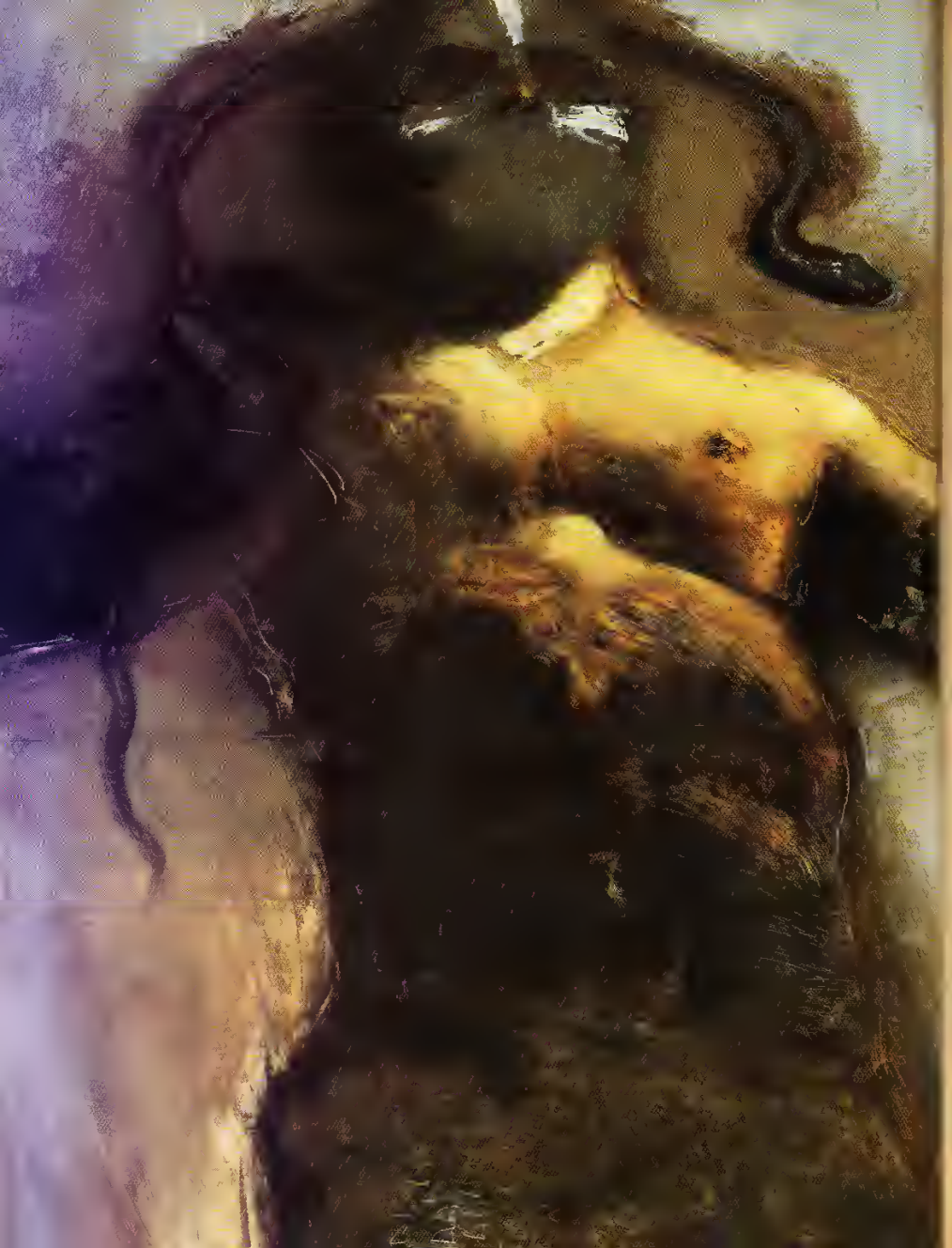
34

MORE THAN SEE: There are 125 million rods and cones in the retina whose impulses follow the pathway to the primary visual cortex, the size of a postage stamp In monkeys, the primary visual cortex is 15 percent of the whole surface of the cortex, in humans, 3 percent, meaning humans have five times as much higher processing of initial visual images

35

BRAIN GENES: Only 1 million genes are necessary to encode for the growth, development, and function of the brain throughout life.

CONTINUED ON PAGE 104



FICTION

THE FIRST CONTACT WITH THE GORGONIDS

BY URSULA K. LE GUIN

JERRY DEBREE WANTED TO SEE SOMETHING REALLY EXOTIC ON HIS TRIP, BUT HE DIDN'T KNOW HOW ALIEN THE OUTBACK COULD BE.

ILLUSTRATIONS BY KENT WILLIAMS

Mrs. Jerry Debree, the heroine of Grong Crossing, liked to look pretty. It was important to Jerry in his business contacts, of course, and also it made her feel more confident and kind of happy to know that her cellophane was recent and her eyelashes really well glued on and that the high lighter blush was bringing out her cheekbones like the girl at the counter had said. But it was beginning to be hard to feel fresh and look pretty as this desert kept getting hotter and hotter and redder and redder until it looked, really, almost like what she had always thought the Bad Place would look like, only not so many people. In fact, none.

"Could we have passed it, do you think?" she ventured at last, and received without surprise the exasperation she had safety-valved from him. "How the fuck could we have *passed* it when we haven't *passed* one fucking *thing* except those fucking *bushes* for 90 miles? *Christ* you're dumb."

Jerry's language was a pity. And sometimes it made it so hard to talk to him. She had had the least little tiny sort of feeling, woman's intuition maybe, that the men who had told him how to get to Grong Crossing were teasing him, having a little joke. He had been talking so loud in the hotel bar about how disappointed he had been with the Corroboree after flying all the way out from Adelaide to see it. He kept comparing it to the Indian dance they had seen at Taos. Actually he had been very bored and restless at Taos and they had had to leave in the middle so he could have a drink and she never had gotten to see the people with the masks come, but now he talked about how they really knew how to put on a native show in the USA. He said a few scruffy abos jumping around weren't going to give tourists from the real world anything to write home about. The Aussies ought to visit Disney World and find out how to do the real thing, he said.

She agreed with that, she loved Disney World. It was the only thing in Florida, where they had to live now that Jerry was an ACEO, that she liked much. One of the Australian men at the bar had seen Disneyland and agreed that it was amazing, or maybe he meant amusing, what he said was "amizing." He seemed to be a nice man. Bruce, he said his name was, and his friend's name was Bruce, too. "Common sort of name here," he said, only he said "nime," but he meant name, she was quite sure. When Jerry went on complaining about the Corroboree, the first Bruce said, "Well, mite, you might go out to Grong Crossing if you really want to see the real thing—right, Bruce?"

At first the other Bruce didn't seem to know what he meant, and that was when her woman's intuition woke up. But pretty soon both Bruces were talking away about this place, Grong Crossing, way out in "the bush," where they were certain to meet real abos really living in the desert. "Near Alice Springs," Jerry said knowledgeably, but it wasn't, they said, it was still farther west from here. They gave directions so precisely that it was clear they knew what they were talking about. "Few hours' drive, that's all," Bruce said. "But y'see, most tourists want to stay on the beaten path. This is a bit more on the inside track."

"Bang-up shows," said Bruce. "Nightly Corroborees."

"Hotel any better than this dump?" Jerry asked, and they laughed. No hotel, they explained. "It's like a safari, see—tents under the stars. Never rains," said Bruce.

"Marvelous food, though," Bruce said. "Fresh kangaroo steaks. Kangaroo hunts daily, see. Witchetty grubs along with the drinks before dinner. Roughing it in luxury, I'd call it; right, Bruce?"

"Absolutely," said Bruce.

"Friendly, are they, these abos?" Jerry asked.

"Oh, salt of the earth. Treat you like kings. Think white men are sort of gods, y'know," Bruce said. Jerry nodded.

So Jerry wrote down all the directions, and here they were driving and driving in the old station wagon that was all there was to rent in the small town they'd been at for the Corroboree, and by now you only knew the road was a road because it was perfectly straight forever. Jerry had been in a good humor at first. "This'll be something to shove up that bastard Thiel's ass," he said. His friend Thiel was always going to places like Tibet and having wonderful adventures and showing videos of himself with yaks. Jerry had bought a very expensive camcorder for this trip, and now he said, "Going to shoot me some abos. Show that tucking Thiel and

THEY WERE PAINTED IN SPOTS OF WHITE ON BLACK, AND

THEIR HAIR WAS LIKE BLACK ROPES STANDING UP ON THEIR HEADS.

his musk oxes!' But as the morning went on and the road went on and the desert went on—did they call it 'the bush" because there was one little thorny bush once a mile or so?—he got hotter and redder and redder just like the desert. And she began to feel depressed and like her mascara was caking.

She was wondering if after another 40 miles (four was her lucky number) she could say, 'Maybe we ought to turn back?' for the first time, when he said, "There!"

There was something ahead, all right.

'There hasn't been any sign,' she said, dubious. "They didn't say anything about a hill, did they?"

'Hell, that's no hill, that's a rock—what do they call it—some big fucking red rock—'

"Ayers Rock?' She had read the WELCOME TO DOWN UNDER flyer in the hotel in Adelaide while Jerry was at the plastics conference. "But that's in the middle of Australia, isn't it?"

"So where the fuck do you think we are? In the middle of Australia, what do you think this is, fucking East Germany?" He was shouting, and he speeded up. The terribly straight road shot them straight at the hill, or rock, or whatever it was. It *wasn't* Ayers Rock, she *knew* that, but there wasn't any use irritating Jerry, especially when he started shouting.

It was reddish, and shaped kind of like a huge VW bug only lumpier, and there were certainly people all around it and at first she was very glad to see them. Their utter isolation—they hadn't seen another car or farm or anything for two hours—had scared her. Then as they got closer she thought the people looked rather funny. Funnier than the ones at the Corroboree even. "I guess they're natives,' she said aloud.

"What the shit did you expect. Frenchmen?" Jerry said, but he said it like a joke, and she laughed. But—"Oh! goodness!" she said involuntarily, getting her first clear sight of one of the natives.

"Big fellows, huh," he said. "Bushmen, they call 'em."

That didn't seem right, but she was still getting over the shock of seeing that tall, thin, black-and-white, weird person. It had been just standing looking at the car, only she couldn't see its eyes. Heavy brows and thick, hairy eyebrows hid them. Black ropey hair hung over half its face and stuck out from behind its ears.

"Are they—are they painted?" she asked weakly.

'They always paint 'emselves up like that.' His contempt for her ignorance was reassuring.

They almost don't look human,' she said, very softly so as to not hurt their feelings, if they spoke English, since Jerry had stopped the car and flung the doors open and was rummaging out the video camera.

"Hold this!'

She held it. Five or six of the tall black-and-white people had sort of turned their way, but they all seemed to be busy with something at the foot of the hill or rock or whatever it was. There were some things that might be tents. Nobody came to welcome them or anything, but she was actually just as glad they didn't.

Hold this! Oh for Christs sake, what did you do with the—all right, just give it here.'

"Jerry, I wonder if we should ask them," she said.

'Ask who what?" he growled, having trouble with the cassette thing.

"The people here—if it's all right to photograph. Remember at Taos they said that when the—"

"For fuck sake, you don't need fucking *permission* to photograph a bunch of *natives*! God! Did you ever *look* at the fucking *National Geographic*? Shit! *Permission*!"

It really wasn't any use when he started shouting. And the people didn't seem to be interested in what he was doing. Although it was quite hard to be sure what direction they were actually looking.

"Aren't you going to get out of the fucking *car*?"

"It's so hot,' she said.

He didn't really mind it when she was afraid of getting too hot or sunburned or anything because he liked being stronger and tougher. She probably could even have said that she was afraid of the natives, because he liked to be braver than her, too, but sometimes he got angry when she was afraid, like the time he made her eat that poisonous fish or a fish that might or might not be poisonous, in Japan, because she said she was afraid to, and she threw up and embarrassed everybody. So she just sat in the car and kept the engine on and the air conditioning on, although the window on her side was open.

Jerry had his camera up on his shoulder now and was panning the scene—the faraway hot red horizon, the queer rock-hill-thing with shiny places in it like glass, the black, burned-looking ground around it, and the people swarming all over. There were 40 or 50 of them at least. It only dawned on her now that if they were wearing any clothes at all she didn't know what was clothes and what was skin, because they were so strange-shaped, and painted or colored all in stripes and spots of white on black, not like zebras but more complicated, more like skeleton suits but not exactly. And they must be eight feet tall, but their arms were short, almost like kangaroos. And their hair was like black ropes standing up all over their heads. It was embarrassing to look at people without clothes on, but you couldn't really see anything like *that*. In fact, she couldn't tell, actually, if they were men or women.

They were all busy with their work or ceremony or whatever it was. Some of them were handling some things like big, thin, golden leaves, others were doing something with cords or wires. They didn't seem to be talking, but there was, all the time, in the air a soft, drumming, droning,

JERRY SHOVED THE CAMERA RIGHT UP CLOSE TO ITS

HEAD, AND AT THAT IT PUT ITS HAND OVER THE LENS.

rising and falling deep sound like cats purring or voices far away

Jerry started walking toward them

Be careful,' she said faintly He paid no attention of course.

They paid no attention to him either as far as she could see and he kept filming, swinging the camera around When he got right up close to a couple of them, they turned toward him She couldn t see their eyes at all, but what happened was their *hair* sort of stood up and bent toward Jerry—each thick black rope about a foot long moving around and bending down exactly as if it were peering at him At that, her own hair tried to stand up, and the blast of the air conditioner ran like ice down her sweaty arms She got out of the car and called his name

He kept filming

She went toward him as fast as she could on the cindery stony soil in her high-heeled sandals 'Jerry, come back I think—

Shut up!' he yelled so savagely that she stopped short for a moment But she could see the hair better now and she could see that it did have eyes and mouths too with little red tongues darting out.

"Jerry come back' she said 'They re not natives, they're Space Aliens That's their saucer" She knew from the *Sun* that there had been sightings down here in Australia

'Shut the fuck up,' he said "Hey, big fella, give me a little action, huh? Don't just stand there Danceedancee, OK?' His eye was glued to the camera

"Jerry,' she said, her voice sticking in her throat, as one of the Space Aliens pointed with its little weak-looking arm and hand at the car Jerry shoved the camera right up close to its head and at that it put its hand over the lens That made Jerry mad of course, and he yelled, "Get the fuck off that!' And he actually looked at the Space Alien not through the camera but face to face "Oh gee,' he said

And his hand went to his hip He always carried a gun, because it was an American's right to bear arms and there were so many drug addicts these days He had smuggled it through the airport inspection the way he knew how Nobody was going to disarm *him*

She saw perfectly clearly what happened The Space Alien opened its eyes

There were eyes under the dark shaggy brows they had been kept closed till now Now they were open and looked once straight at Jerry, and he turned to stone He just stood there one hand on the camera and one reaching for his gun, motionless

Several more Space Aliens had gathered round They all had their eyes shut, except for the ones at the ends of their hair Those glittered and shone and the little red tongues flickered in and out, and the humming, droning sound was much louder Many of the hair-snakes writhed to look at her Her knees buckled and her heart thudded in her throat, but she had to get to Jerry She passed right between two huge Space Aliens and reached him and patted him—'Jerry, wake up!' she said He was just like stone, paralyzed 'Oh she said, and tears ran down her face "oh, what should I do what can I do?" She looked around in despair at the tall, thin, black-and-white faces looming above her, white teeth showing, eyes tight shut, hairs staring and stirring and murmuring The murmur was soft, almost like music, not angry, soothing She watched two tall Space Aliens pick up Jerry quite gently, as if he were a tiny little boy—a stiff one—and carry him carefully to the car

They poked him into the back seat lengthwise, but he didn't fit She ran to help She let down the back seat so there was room for him in the back The Space Aliens arranged him and tucked the video camera in beside him, then straightened up, their hairs looking down at her with little twinkly eyes They hummed softly, and pointed with their childish arms back down the road

"Yes," she said "Thank you Good-bye!"

They hummed

She got in and closed the window and turned the car around there on a wide place in the road—and there *was* a signpost, Grong Crossing, although she didn't see any crossroad

She drove back, carefully at first because she was shaky, then faster and faster because she should get Jerry to the doctor, of course, but also because she loved driving on long straight roads very fast like this Jerry never let her drive except in town

The paralysis was total and permanent which would have been terrible, except that she could afford full-time, round-the-clock, first-class care for poor Jerry, because of the really good deals she made with the TV people and then with the rights people for the video First it was shown all over the world as *Space Aliens Land in Australian Outback*, but then it became part of real science and history as *Grong Crossing, South Australia The First Contact With the Gorgonids* In the voice-over they told how it was her, Annie Laurie Debree who had been the first human to talk with our friends from outer space even before they sent the ambassadors to Canberra and Reykjavik There was only one good shot of her in the film, and Jerry had been sort of shaking, and her highlighter was kind of streaked but that was all right She was the heroine

Ursula K Le Guin's most recent book is Searoad *(HarperCollins, 1991) Her 1990 novel* Tehanu *won the Nebula Award, and she has also won the Hugo and the National Book Awards*

MAPPING THE MINDFIELDS

Hord wired: Williamson opplies solid- stote physics to examine the brain ot work.

The huge padded door opens. Beneath subdued lights, a man lies prone, his head held stationary by a vacuum pillow used to immobilize broken bones. He stares up at a large, fiberglass, cylindrical probe, which with infinitessimal slowness, descends toward his forehead and stops within a millimeter from his skin. A radio-frequency transmitter on the probe communiates with two electronic cubes secured by a velcro sweatband on his forehead, marking the probe's target inside his skull. Racks of electronic machines surround him. A wiry, energetic professor with an impish sense of humor, adjusts e dial, and with a glance, motions me to follow him out. The door whooshes shut.

I am not in an operating room of the twenty-second century, but on the ninth floor of New York University's Physics Building, in a lab where solid-state physics and the "wet" world of neuroscience interpenetrate. Instead of microscopes focused on thin slices of brain tissue, the rooms are crowded with electronic scanners, oscillators, and computers. Qne of the more impressive machines has stenciled on it *NEUROMAGNETOMETER*. The mouthful of a title describes our planet s most sensitive detector of magnetic fields, capable of measuring the magnetic fields emaneting from a human brain, only one billionth of Earth's geomagnetic field.

This particular machine is registering the brain of graduate student Zhong-Lin Lu, and it is doing so to create a topographical map of his thoughts.

"It's amazing how little we know about our brains," says the lab's director, Samuel Williamson, the neuroscientist who, with his psychologist partner, Lloyd Kaufman, is a leading pioneer of this strange new cartography. Formerly a solid-state physicist more interested in superconductive phenomena, Williamson was led to brain mapping through his fascination with the SQUID. 'Not calamari," he says, "superconducting quantum interference device. S-Q-U-I-D."

SQUIDs take advantage of e subtle quantum effect. At extremely low temperatures where electrons couple together, they form waves. These waves can be thrown out of sync by the weakest magnetic fields. SQUID sensors measure these fluctuations.

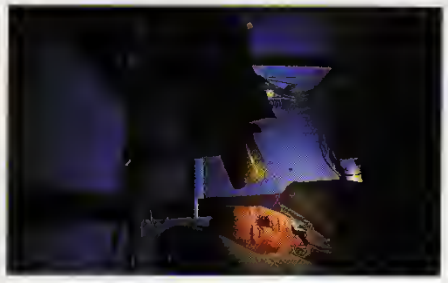
"So what does this have to do with the brain?" Williamson asks rhetorically. I nod, but he's not about to tell me yet. First he wents to talk about how SQUIDs work. "This fancy container over Lu's head is nothing but a Thermos bottle. It relies on the same vacuum insulation as your Thermos, we just have a heck of a better vacuum."

At the bottom of the probe, are five coils wound of superconducting nioblum wire bathed in liquid helium at four degrees Kelvin (about -450Á F). Each coil has a SQUID sensor atteched to it. When a magnetic field appears, it generates a current in the coil's superconducting circuit. A SQUID, sensing the fields flowing in the coil, converts it to a voltage. 'The fancy electronics outside monitor the SQUID's responses and provide signals that mimic the magnetic field of the brein. By monitoring the rhythms of Alpha waves, we can get a real-time photo of where certain thoughts are going on in Lu s mind."

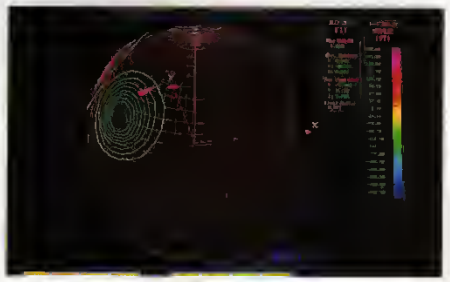
Alpha waves? The mysterious biofeedback stuff that was the rage of the sixties? 'The same wave," Williamson admits. Alpha waves are not exotica or part of an ersatz science, but real and rhythmic in a bandwidth of 8 to 13 cycles per second. They are measurable and originate in many parts of our brain when we're alert yet relaxed—thus the meditation link. Some call it the "idling wave," but the Alpha's actual purpose, says Williamson, has yet to be explained.

ARTICLE BY BOB BERGER

An orray of SQUIDs is slowly being lawered to within a millimeter of a subject's skin.



Magnetic field maps reveal not only the mind's eye, but the mind's ear and the mind's voice.



It's not Alpha waves per se that interest the NYU neuroscientist. With the SQUID he's able to monitor tiny, specific areas where the Alpha rhythm briefly stops. The power goes off, so to speak. This occurs, for example, when you use your brain to access a memory. It stops, too, when you make a comparison between one image and another. But it stops in a different area of the brain. The various patterns of "Alpha suppression," in fact, may be the patterns of thought in action.

Although there is no standard for Alpha-wave rhythm (in some folks it's stronger than in others), the sources of each individual s rhythms can be located. The array of SQUID sensors is placed over a predetermined brain area. With care, it's possible to the locate a center of activity with en accuracy of three millimeters.

With the neuromagnetometer, Williamson tests a brain function—recognizing a face—and notes if, when, and to what degree the spontaneous Alpha waves briefly stop.

A test is occurring right now. In that eerie "noise-proof" room (noise-proof meaning magnetic-proof, the walls are lined with mu-metal, a nickle-bearing substance that literally attracts megnetic fields and guides them around the chember), Lu lies beneath the probe. From the other room, Williamson whispers to him via an intercom. 'Imagine a boat," he commands. Beside me, Williamson points to a computer screen where the squiggles have abruptly stopped. 'The sensors are isolating an area in Lu's brain where there's a suppression of Alpha waves, Lu is seeking the image of a boat.' The area isolated is the primary visual cortex, the region in the back of the head where everything we see from the outside world has its basic processing.

The point, according to Williamson, is not what Lu imagined, or even that the Alpha was suppressed for a second as Lu's association occurred. What's important is the strength of the suppression and especially where it occurred. This demonstrates that primary visual areas are involved with mental imaging, the visions inside our heads. "When we generate images, mentally compare an image with others previously seen, or even respond to a word shown on a screen by finding an image for the object the word represents," he says, "it looks like we use the primary visual area and also an area very close to it. Which means that where the brain responded to the visual image of the word *boat* and where it 'saw' the image of a boat are next-door neighbors. "Which means," Williamson says, 'that visual brain areas take part in forming what we call the mind's eye, a place where visual associations occur."

The mind's eye. And not just that, but the mind's ear and the mind's voice.

Do we also remember music and invent sounds in the same place where they were originally recognized? Do those sweet unheard melodies, as John Keats once said, occur in the same auditory cortex as the heerd melodies? "Qf course," Professor Williamson continues, 'we don't know how a composer uses previously heard sounds to create a new melody.

PHOTOGRAPH BY DAN McCOY

Caught in the act: Magnetic fields fluctuating from left to right. The direction will then reverse, and this cycle will be repeated—about 12 times a second.

WE'RE JUST AT THE

beginning stages of this work, which is why we need a map, so we can find our way back when we've increased our skills." Williamson and Kaufman's mapping has confirmed that there is a tonal map in the "hearing brain" that mirrors musical scale. The NYU team showed that a group of nerve cells in a tiny area of the temporal lobe reacts to a C note, another group to a C sharp, and so on up the scale like the ivories on a keyboard. A topographical map.

"As we map the mind,' Williamson says, "we discover how highly organized and very efficient it is. Everything seems to have its logical juxtaposition." Ever more frequently, the brain is being compared to a supercomputer, although with its trillions of interconnections and distributed networks a brain is far more sophisticated than the most advanced parallel processor. Yet metaphors abound of tiny, individual, wet computers linked and working simultaneously to solve immensely complicated tasks—functions within functions. "We have known about the brain's so-called supercomputer but not how it works, where all the tiny components are, how the tasks are broken down," he admits.

Williamson provides an example of mental multitasking. "Suppose we're alone in the jungle and see a tiger. Part of our visual system sees stripes, another sees movement, approximately at the same instant. With magnetic field measurements, we can determine their interplay and which part dominates." (Williamson thinks it's the stripes part that dominates unless the tiger is jumping at you, then a motion detection system kicks in first.) "From there we hope to find where the tiger memory is stored ('What is a tiger?') and, finally, how to react ('run like crazy')."

"In short,' Williamson says, "we are beginning to learn what's happening during this complicated series of tasks. It's truly brand-new stuff.' Practically brand-new stuff. Magnetic imaging's first studies of the brain's response to visual display were done at NYU in 1972 by Williamson and Lloyd Kaufman and their "long-suffering" grad student, Douglas Brenner. In 1975 their first paper appeared. Much trial and error were needed to sort out irrevelant noise, the bane of the machine. "You want to know what real noise is? The BMT line 12 stories below the lab. We did the early work without any noise shielding at all. That's trial and error!"

But from its murky beginnings, the neuromagnetometer has been improved by a factor of more than 10. From simply corroborating the easiest neural tasks, the Williamson/Kaufman team is now on the frontier of major mapping discoveries. Thanks to Williamson and Kaufman's early work, there are now 50 groups around the world doing biomagnetic studies.

What's holding back progress? Mostly it's money. Williamson's SQUID uses an array of just five sensors, which is sort of like measuring a whale with your thumbnail. To construct a topographical field map of a cortical region, you have to measure at 30 to 70 locations. Next years's funding should bring a system of 37 sensors. A group at the Low Temperature Laboratory of the Helsinki University of Technology is building a machine with 122 SQUIDs sampling the whole head. A consortium of Japanese corporations in collaboration with MITI (Ministry of International Trade and Industry) are about to unveil one with 200 SQUIDS.

"That many sensors and the software to coordinate them will move us to the next step," Williamson says. "A system that can monitor the field anywhere about the head."

What will we do with the new mind atlas? "Well, use the part of your mind that imagines," says Williamson. "There are many exciting applications, many in preventive medicine. Ultimately, we hope it may help to distinguish between psychiatric disorders. One area where it probably won't be used is the operating room. 'Too much noise — electrical devices,' he says, though surgeons will refer to its data during surgery." Won't that be the same as referring to CAT scans? "The neuromagnetometer sees what CAT scans can't. It provides a functional image, not an anatomical one—and it's noninvasive. Its also complementary to PET, but has a more rapid time response. You follow changes quickly."

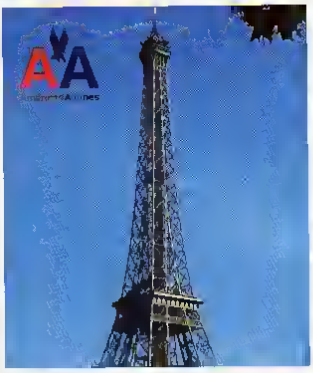
One application which Williamson has suggested is the annual brain check. "Every six months you go see your dentist. Why not a brain checkup, too? If we know what your normal brain looks like magnetic-fieldwise, we can compare. Deviations can be noted, problems nipped in the bud." At present, though, there is that nagging lack-of-database problem. Not enough brains have been 'SQUIDed.' But with a large enough array of sensors and the lower cost that mass production might bring, one day we might simply sit under this hairdryer-looking device and in a matter of minutes get a complete picture of our mind live and kicking in real time.

At the Henry Ford Clinic in Detroit and elsewhere, neuroscientists are using neuromagnetometers to study the causes of migraines and epilepsy. The data is already available to perform rudimentary hearing tests on infants. Early detection for tumors, Alzheimer's disease, and many other brain problems are realistic prospects. "And of course,as the brain records what's going on in the rest of the body,it could provide helpful signals."

And more esoteric testing? Determining genius, for example? "Why not?" Williamson replies. "We have no clue at the moment of what to look for, but that doesn't mean it couldn't be done. Such things are eventually solvable and doable." What about studying unusual powers of thought and creativity? Peering at the playwright John Guare's brain? The thought processing of computer maven William Gates? A test to determine a child's potential? And while we're at it, a means to expand and widen the highways of our own imaginations by means of, say, a biomagneticfeedback machine? "Why not?" Williamson says again. If we can understand the organ that understands, anything's possible. And if you have a good map, you can go just about anywhere.

One of these prizes could be yours if you can follow the clues in

THE GREAT OMNI TREASURE HUNT



Reading OMNI is always rewarding, but especially so next month. The February issue features our eighth annual Great OMNI Treasure Hunt where a little bit of detective work can pay off in fabulous prizes!

Here's a sneak preview of a few of the prizes. Just imagine the fun you could have if you won our GRAND PRIZE, a 1992 GEO Tracker LSi 4x4 Convertible, complete with sporty aluminum wheels (value $12,935)!

Other prizes include a 1992 HONDA Nighthawk 750 Motorcycle (value $4,199). There's also a roundtrip flight for two on American Airlines to one of the world's most romantic cities, Paris, France (value $2,000). And that's only the beginning.

So be sure to see the February issue of OMNI for official rules, clues, and a look at the rest of the prizes. Don't miss it!

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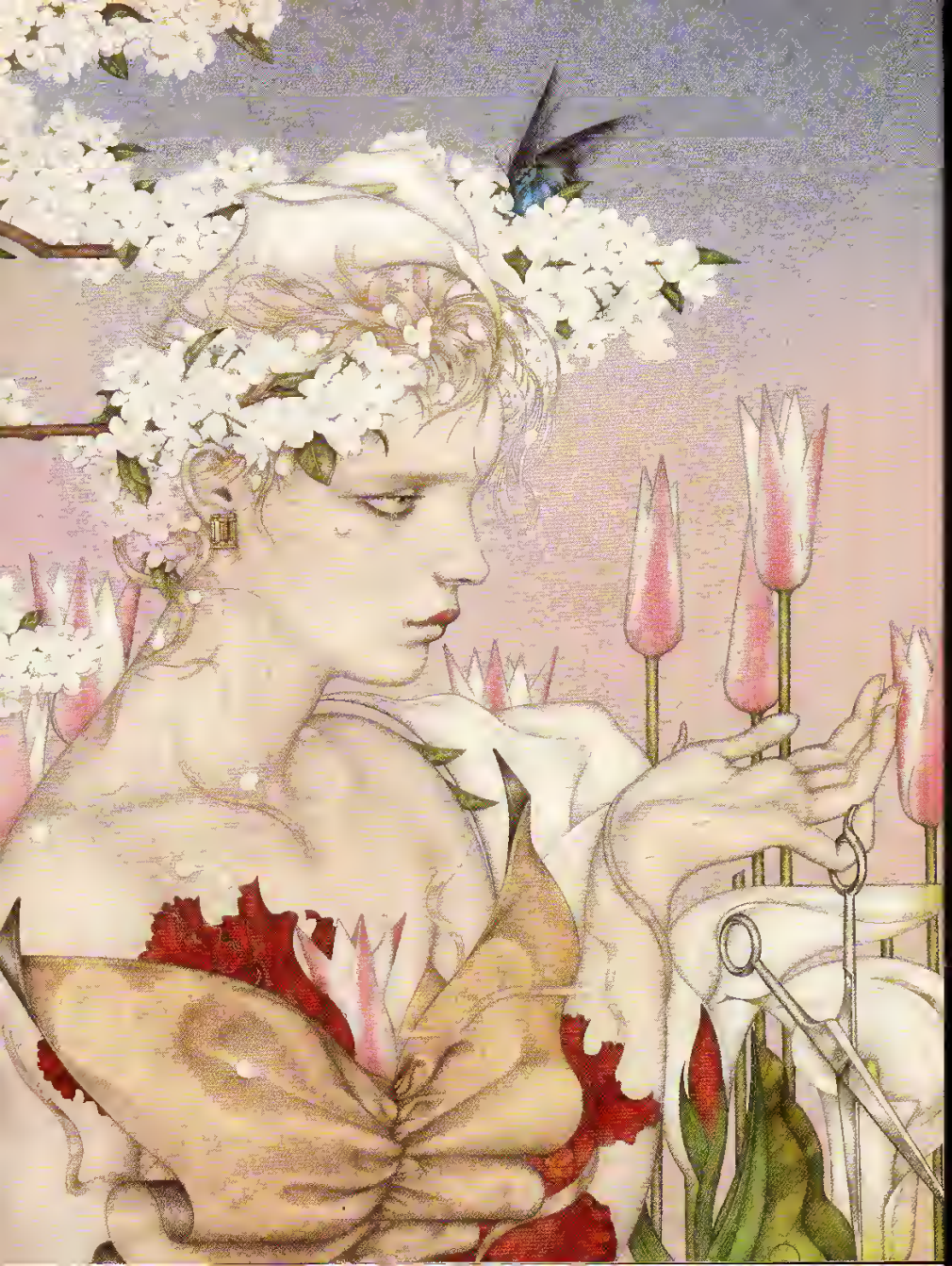
"LET'S STOP MOURNING FOR THE GOOD OLD DAYS. WE ARE LARGELY LIVING IN THEM STILL."
—EUELL GIBBONS

MY LAST WEEK ON THE JOB STARTED [AS USUAL] WITH A CRISIS. "CODE FOUR, GAIL," CARL SAID, THROWING ME MY CAP. HE NEVER COULD PRONOUNCE MY NAME. "IT'S THE BARBERS, OUT IN WHISPERING WOODS SUBDIVISION, SOUTH OF NEW BRUNSWICK, JUST OFF ROUTE ONE." HE BACKED THE PICK-UP TO THE CARL'S LAWN & GARDEN SHED END OF THE GREENHOUSE AND QUIZZED ME WHILE I THREW EQUIPMENT INTO THE BACK. "GOT THE DRIP NOZZLES?

FICTION
BY TERRY BISSON



"IT WAS THE ONLY ORGANIC LAWN IN THE SUB, AND FOR TWO YEARS IT ALMOST MADE IT, BUT NOW THIS LOOKED LIKE THE END.

Got the four plus six? Got the Sylovan, the DI50SI? The lawn projectors? The Thumper, just in case? Oh, and a Dutch Elm chip for the mall. We might make it by there today."

It was a bright, mournful June day. The traffic was colorful and hard. The roadsides were brilliant green, newly painted for spring.

"Here we are, Gail. Whispering Woods." We pulled past the wrought-iron gates, between the two big laser maples with Dolby rustling leaves, and around the curved drive lined with big houses set on wide pseudolawns. It was all "nerf and turf" (that's what Carl calls verdechip and astrolawn) until the Barbers' house at the turnaround.

Their lawn was not green but yellow-green. It was the only organic lawn in the sub. We put it in for them four years ago, and for two years it almost made it; then last summer we had to put it on 24-hour IV, and now this looked like the end of the line.

Mrs. Barber was standing at the door looking worried. Her husband pulled in the drive just as we did. She must have called us both at the same time.

"Jesus," Mr. Barber said as he got out of his Chrysler Iacocca and looked at his yellowing hundred thousand dollars ($104,668.29 to be precise; I sometimes watched Carl do the books). "It's not too late, is it, Carl?"

"It's never too late, Mr. Barber," Carl said. The greenest part of the lawn made a crisscross pattern like an X ray showing the underground grid where the drip saturators were buried, the rest of the grass was jaundiced yellow. A darker brown edge ran all around the yard, like paper just before it bursts into flame.

"Code Six, Gail," Carl said, revising his original assessment. "Give me four point five liters of straight Biulofermicaine on a speed inject. And be quick about it. I'll load up the ambuliofogger."

The nutritank was built onto the side of the ranch-style home, disguised as a shed. I spilled in a four-can of Bi, added some Phishphlakes for good measure, and [illegible]. Out front, Carl trotted up and down the lawn with a Diprothemytaline sprayer, while the Barbers looked on, worried, from the doorway. A few neighbors had gathered at the curb, a mixture of concern and poorly disguised pleasure on their faces. I could tell that the Barbers and their organic lawn were not popular.

The quick Dipro fix gives a green flush to the skinny little leaves of the grass. I could hear them sigh with relief through the soles of my feet. But unless the satura-solution coming up from the IV grid found living roots, the whole thing would be a waste.

Carl looked grave as he put the sprayer back into the truck. "If it's not looking better by Wednesday, call me," he said to the Barbers. "You have my home phone number. We'll stop by on Friday to adjust the IV solution, and I'll check it then."

"How much is this—going to cost?" Mr. Barber whispered, so his wife and the neighbors couldn't hear. Carl gave him a mournful, disapproving look, and Mr. Barber turned away, ashamed.

"Hell, I understand where he's coming from, though," Carl told me when we were back on the road. "It used to be that when you bought a lawn you could get insurance, especially with a new house, but these days nobody is insured. You can insure a tree, a potted one, anyway, or a cybershrub, and of course any kind of holo. But a living lawn? Jesus, Gail, no wonder the guy's worried."

Carl's empathy is his best quality.

We stopped for lunch at Lord Byron's on the Princeton bypass; it's the only place that'll allow a girl with no shoes. Lord Byron was a cook at a veterans' hospital for twenty years before he saved enough to open his own place. Because of this medical background, he thinks he's a doctor.

"The usual," said Carl. Two beers and a sloppy joe on a hard roll.

Lord Byron lifted my cap and his huge warm black hand covered the top of my head. "Just as I thought," he said. "Cold as ice. Sure you can't find something on the menu you can eat, Gay?"

He never could say my name right either.

After lunch we changed the motherboard on a flower bed at a funeral home on Route 303. The display

ILLUSTRATIONS BY
MEL ODOM

was one of those cheap, sixteen-bit jobs that you can't walk through, that only look right from a hundred yards or so. Carl had sold it to them last fall. It was supposedly upgradable, but in fact the company that made it had gone out of business over the winter, and now the chip was an orphan; you couldn't change the variety or even the colors of the flowers without a whole new CPU.

Carl explained this hesitantly, expecting an argument, but the funeral home manager signed for the new chip, a Hallmark clone, in a minute. "It's one of these franchise operations, Gail," Carl said on the way back to the shop. "They don't care what they spend. Hell, why should they? It's all tax-deductible under the Environmental Upgrade Act. I never liked flowers much anyway. Even organic ones."

Tuesday was a better day because we got to dig. We put in ten meters of Patagonian Civet Hedge at Johnson, Johnson & Johnson. Pat is not really Patagonian, the name is supposed to suggest some kind of hardy stock. It's actually cyberhedge, a fert-saturated plastate lattice with dri-gro bud lodgments at twenty-millimeter intervals on a 3-D grid. But the tiny leaves that grow out of it are as real as I am. They bask in the sun and wave in the wind. The bugs, if there were any, would be fooled.

Carl was in a great mood. Ten meters of Pat at three hundred and twenty-five dollars a meter is a nice piece of change. And since the roots themselves are not alive, you can put them directly into untreated ground. There's something about the sliding of a shovel into the dirt that stirs the blood of a nurseryman.

"This is the life, right, Gail?" Carl said.

I nodded and grinned back at him. Even though something about the dirt didn't smell right. It didn't smell wrong. It just didn't smell at all.

After lunch at Lord Byron's, Carl sold two electric trees at the Garden State Mall. The manager wanted the trees for a display at the main entrance, and Carl had to talk him out of organics. Carl doesn't like the electrics any better than I do, but sometimes they are the only alternative.

"I sort of wanted real trees," the manager said.

"Not outdoors you don't," Carl said. "Look, organic trees are too frail. Even if you could afford them—and you can't—they get weird diseases, they fall over. You've got to feed them day and night. Let me show you these new Dutch Elms from Microsoft." He threw the switch on the holoprojector while I started piecing together the sensofence. "See how great they look?" Carl said. "Go ahead, walk all the way around them. We call them The Immortals. Bugs don't eat on them, they never get sick, and all you have to feed them is one-ten. We can set this projector up on the roof, so you don't have to worry about cars running over it."

"I sort of wanted something that cast a shadow," the manager said.

"You don't want shadows here at the mall anyway," said Carl, who had an answer for everything when he was selling. "And you won't have to worry about shoppers walking through the trees"—he passed his hand through the trunk—"and spoiling the image either. That's what this fence is for, which my lovely assistant is setting up. Ready, Gail?"

I set two sections of white picket fence next to the tree and snapped them together.

"That's not a holo," said the manager.

"No, sir. Solid plastic," Carl said. "And it does a lot more than just keep people from walking or driving through the trees. The pickets themselves are sophisticated envirosensors. Made in Singapore. Watch."

I turned on the fence, and since there was no wind, Carl blew on a picket. The leaves on the trees waved and wiggled. He covered a picket with his hand and a shadow fell over the treetops. "They respond to actual wind and sun conditions, for the utmost in total realism. Now, let's suppose it looks like rain. . . ."

That was my cue. I handed Carl a paper cup and he sprinkled water on the pickets with his fingertips, like a priest giving a blessing. The leaves of the trees shimmered and looked wet. "We call them the Immortals," Carl said again, proudly.

"What about birds?"

"Birds?"

"I read somewhere that birds get confused and try to land in the branches or something," the manager said. "I forget exactly."

Carl's laugh was suddenly sad. "How long since you've seen a bird?"

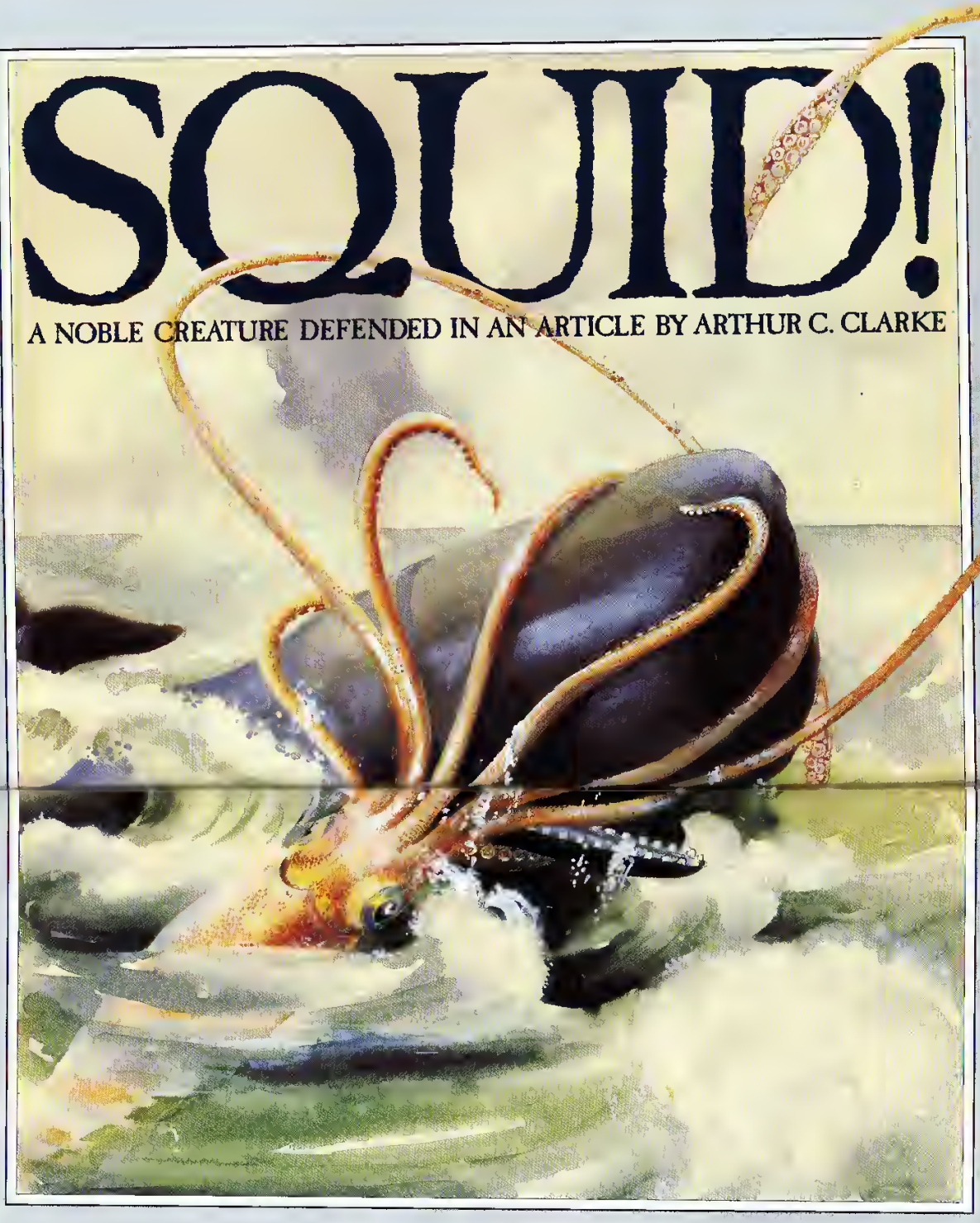
Wednesday was the day we had set aside to service Carl's masterpiece, the Oak Grove at Princeton University. These were not allanth-oaks or composite red "woods"; these were full-sized white oaks of solid wood that grew not out of pots but straight out of the

"We'll run some tests to see what his reaction is to being overcharged."

CONTINUED ON PAGE 96

SQUID!

A NOBLE CREATURE DEFENDED IN AN ARTICLE BY ARTHUR C. CLARKE



It's seven-something on Monday morning, July 29, in the very heart of Sri Lanka's tea country, and I'm admiring the gorgeous view from my hotel room. I'm completely relaxed because the nearest fax machine is twenty kilometers and thirty hairpin bends down the mountain road to Kandy. There's no way that editors and agents can bother me.

Then I casually tune my radio to the Voice of America, and within seconds my tranquility is shattered by something that concerns me directly. Peter Benchley is promoting his new book and mentions Sri Lanka.

After *Jaws*, what? Well, as most of the American public must know by now, the menace in *Beast* is the giant squid. Good for you, Peter—but why did it take you so long? After all, it's a pretty obvious idea. I should know.

Soon after *Jaws* was released, its producers, Richard Zanuck and David Brown, asked me if I'd like to write the scenario for *Jaws 2*. I replied that when you've seen one Great White Shark, you've seen them all, and I wasn't interested. If they wanted a *real* monster, it would be hard to beat the giant squid, *Architeuthis*. So I promptly sat down and wrote an outline, based partly on a story of mine that *Playboy* had published in 1964 ("The Shining Ones," reprinted in *The Wind From the Sun*). I couldn't resist calling it "Tentacles," although I realized that this would provoke lewd sniggers at the box office.

Anyway, though I had a pleasant telephone discussion with Messrs. Zanuck and Brown, and later sent them my outline, nothing came of the project. I was not in the least disappointed, as by then I was much too involved in *2010 Odyssey Two*.

By a curious coincidence, Roy Scheider starred in both *2010* and in *Jaws*, where he delivered one of the greatest throwaway lines in movie history. Who can forget the moment when he tells Capn Quint (Robert Shaw), "You've got to get a bigger boat"? (Stanley Kubrick, incidentally, once considered using Shaw in *2001: A Space Odyssey*. Had he done so, the story line might have been very different.)

As yet another aside, I can claim some slight involvement with the chain of events which led to *Jaws*. One of its major inspirations was undoubtedly Peter Gimbel's remarkable adventure film, *Blue Water, White Death*. At my suggestion, Peter sailed to Sri Lanka, and in 1969 I visited his battered rust-bucket, then anchored off the east coast near the wreck of the early aircraft carrier H.M.S. *Hermes*. On deck were the shark cages from which Peter hoped to film the Great White when he caught up with it—as, indeed, he did a few months later in Australia, with spectacular results. I don't think those cages would be much use, however, against *Architeuthis*. Its tentacles—at least the smaller ones—could certainly insinuate themselves through the bars.

It must now be sixty years since I first discovered the giant squid in Frank Bullen's account of life on a nineteenth century whaler, *The Cruise of the Cachalot*. The book had a terrifying and unforgettable frontispiece, which was certainly the inspiration for this passage in *Childhood's End* (1953):

Arthur C. Clarke is the author of such science fiction classics as Childhood's End *as well as many popular science books.*

The long, saw-toothed lower jaw of the whale was gaping wide, preparing to fasten upon its prey. The creature's head was almost concealed beneath the writhing network of white, pulpy arms with which the giant squid was fighting desperately for life. Livid sucker-marks, twenty centimeters or more in diameter, had mottled the whale's skin where those arms had fastened. One tentacle was already a truncated stump, and there could be no doubt as to the ultimate outcome of the battle. When the two greatest beasts on earth engaged in combat, the whale was always the winner. For all the vast strength of its forest of tentacles, the squid's only hope lay in escaping before that patiently grinding jaw had sawn it to pieces.

That was merely the beginning of my literary involvement with *Architeuthis*. A few years later (1957) the short story "Big Game Hunt" (reprinted in *Tales From the White Hart*) was a tongue-in-cheek account of an attempt to capture a giant squid—a project which had most deplorable consequences for all concerned.

In the novel *The Deep Range* (1957) I took this idea more seriously, describing a scheme for immobilizing a giant squid and bringing it safely back to the surface for for observation, using chemical anesthesia and electrified fences. It might even work. I'd like to see some millionaire try it out.

My favorite treatment of the subject, however, occurs in the story already mentioned, "The Shining Ones." This tale may one day have some practical repercussions, because it pointed out that Sri Lanka's magnificent east coast harbor of Trincomalee would be an ideal site for an Ocean Thermal Energy Conversion (OTEC) plant, using the temperature difference between the surface and the freezing abyssal waters as a source of power. Efforts are now under way to put this idea into practice.

In "The Shining Ones," an OTEC project was frustrated by a species of giant squid that, alas, probably does not exist. I assume there was a variety that—like their smaller cousins, the cuttlefish—could communicate by rapidly changing luminescent patterns, so they were, in effect, living TV screens. The last words of my hero, before he descends on his final dive to repair the damaged installation in the Trinco canyon are, "Whatever happens, please remember this—they are beautiful, wonderful creatures. Try to come to terms with them if you can."

So much for fiction, now for fact. When I was making my television series, *Arthur C. Clarke's Mysterious World*, I was determined to feature the giant squid, and by great good luck, Yorkshire TV's camera crew was able to film one that had been cast ashore in Newfoundland. Millions of viewers have seen the resulting sequence, although the specimen was only an immature female, a mere twenty-five feet long, it is scary enough, and gives a very good idea of what the *really* big specimens must look like—especially if, as the evidence suggests, they grow up to 150 feet in length.

In his radio interview, Peter Benchley mentioned the case of the schooner *Pearl*, reported (by the London *Times*, 4 July 1874) to have been sunk in the Bay of Bengal by a giant squid, a few days after leaving Sri Lanka's southern port of Galle. My beach bungalow is just a couple of kilometers further along the coast, so I stood at the water's edge and described how the unlucky schooner must have passed this

> "Whatever happens, please remember this—they are beautiful, wonderful creatures. Try to come to terms with them if you can."

very spot on the way to her Close Encounter of the Fatal Kind.

The giant squid that sank the *Pearl*—after her master's completely unprovoked rifle fire, let it be noted—was lying on the surface exactly like the specimen described in Chapter 59 of *Moby Dick*:

In the distance, a great white mass lazily rose, and rising higher and higher, and disentangling itself from the azure, at last gleamed before our prow like a snow-slide, new slid from the hills. Thus glistening for a moment, as slowly it subsided, and sank. Then once more arose.

Almost forgetting for the moment all thoughts of Moby Dick, we now gazed at the most wondrous phonomenon which the secret seas have hitherto revealed to mankind. A vast pulpy mass, furlongs in length and breadth, of a glancing cream-colour, lay floating on the water, innumerable long arms radiating from its centre, and curling and twisting like a nest of anacondas, as if blindly to clutch at any hapless object within reach.

We now know that a giant squid that has surfaced in tropical waters is almost certainly dying—though not necessarily harmless, as the *Pearl* discovered. Its blood functions efficiently only at the very low temperatures a few degrees above freezing point, found in the abyss. In warm surface waters, the blood's ability to absorb oxygen is greatly reduced, so any squid in these circumstances is literally suffocating. This is reassuring news for swimmers and divers in the tropics, but they shouldn't press their luck. And in subarctic waters, the giant squid can be agressively hungry—as was demonstrated by the life-raft incident described in "Mysterious World," when one survivor carried sucker scars to his grave.

Needless to say, I can't wait to read *Beast*, and though I wish it luck, I'm more than a little worried about its impact. *Jaws* was largely responsible for the appalling carnage wreaked upon the shark population during the last couple of decades, which now has marine conservationists seriously alarmed. In fact, P. Benchely is probably the worst thing that's happened to sharks since that asteroid polished off the dinosaurs around 65,000,000 B.C. and boiled the Gulf of Mexico.

I sincerely hope he does not trigger another ocean pogrom, aimed at the giant squid. If he does, it will serve him damn well right if he catches one the next time he's out fishing.

This century has seen a complete transformation in our attitude toward other animals, including many once considered implacably hostile. This is particularly true of marine mammals: witness oceanarium trainers putting their heads in the jaws of killer whales—once regarded as the most ferocious of all marine mammals. And there's a local guide (not with *my* company) who feeds sharks by presenting fish to them—*in his mouth*. The last time I saw him, he did have a few scars.

Such underwater antics suggest an interesting possibility. The giant squid is almost certainly a highly intelligent animal, given the opportunity, it might be as playful as its cousin—that charming mollusk, the common octopus.

Who will be the first diver to win *Architeuthis*'s friendship, and snuggle down comfortably in that "nest of anacondas"?

No, I'm not volunteering. As "Mysterious World" showed, my dive gear is a tasteful shade of yellow.

P.S.

Hated *Jaws 2* because it had such a tragic ending. All those horrible brats survived, while the beautiful shark got turned into fried fish.

INTERACTIVE RESOLUTIONS

BY KEITH FERRELL

We've made it a practice the last couple of years to take an occasional look at the evolving nature of interactive electronic entertainment: video and computer games. In the interactive entertainment industry, better perhaps than anywhere else, we get a clear glimpse of the power of silicon technology to reach almost *everyone*. Games exert an all but universal appeal. As a result, the interactive video revolution has achieved success of all but overwhelming proportions. Even as some pundits and analysts suggest a softening of the market, they're looking at a thriving, multibillion-dollar endeavor.

On the following pages science-fiction writer and *OMNI's Electronic Universe* columnist Gregg Keizer lets his imagination roam through the decades ahead, speculating about the interactive futures that today's successes might build. There are exciting worlds waiting for us.

Here we'll take a moment to offer some New Year's resolutions—suggestions, really—that might help guide you through the interactive entertainment marketplace.

1) Let your taste in software guide your hardware purchases. This sounds simple, but considering the number of different video and computer systems available, it's easy to make a misstep. Shop around; play different systems in stores or in friends' homes, check out the software racks.

2) If buying a system for children, look at its durability as well as the range of software available for ages and tastes. Video games can be frustrating as well as engaging, shop for engagement.

3) Consider a computer as well as a video game console. The two are not mutually exclusive. Don't rule out a computer for children. Recent months have seen the introduction of hardware peripherals and software products developed specifically for younger users. Additional value accrues as the computer grows with the child.

4) If you buy a computer, buy the most fully functional and multiply useful one you can afford. If you're going to use the system for entertainment, you'll want graphics and sound. Get plenty of memory and storage capacity. Buy an expandable computer.

5) Be alert and open to new technologies. 1991 saw multimedia technology begin to come of age, offering enhanced motion and sound as well as increased capacity via CD-ROM and other publishing technologies. It costs more, but you get more.

6) Don't play in a void. This is the most subjective of the recommendations, but one worth considering. Interactive doesn't mean simply interacting with the video game or computer. get a system that will let you play with friends and family members as well as solo. If you buy a computer, consider adding a modem to put you in touch with players all over the globe. Play throughout human history has been a means of getting people together. The same can be true of electronic play.

Fortunately, despite—or perhaps because of—a poor economy, interactive technology prices are dropping precipitously, even as the power of the technology climbs higher. A couple of hundred dollars buys a state-of-the-art video game console. Two thousand dollars or less can net you a computer system that would have cost five times as much just a couple of years ago. Half that gets you a perfectly serviceable computer that can handle all but the most sophisticated entertainment software.

Technology evolves. Be prepared for that. The system you play on today and the games you play on it may look like antiques in just a few years.

And when that time comes, when new systems come online, you'll see yet another leap in the power of interactive entertainment software to delight and divert, inform and entertain, to provide play that's not quite like anything that preceded it.

ALL TOGETHER NOW

Pay your phone bill. That's one piece of advice you should take to heart—and to the end of the decade—if you're playing games at home.

Silicon entertainment may be a solitary sport at the moment—man against machine in an uneven contest—but as phone lines link players in webs that stretch across the country, conceivably across the globe, solitaire gaming will give way to endless, ongoing contests between partners, teams, and roving electronic bands. Social interaction may be the result, but the driving force behind phone play will be human competition. What fun is there in beating a bonehead computer?

Online entertainment first won a beachhead among the modem crowd with easy-to-display board and card games like chess, backgammon, and blackjack. Multiplayer combat followed, like GEnie's Air Warrior, a simple air battle. Select computer games offered one-on-one play over phone lines. Game-specific networks even rose to the challenge and drew players with promises of instant access to opponents and high-quality group games.

But what's available today—from The Sierra Network's theme park-style construction to *Falcon* 3.0's head-to-head flight simulator—is but a digital taste test of what you'll pick from by the end of the nineties.

Telecommunications giants are getting ready to move from information transmitters to information providers. Fiber-optic cable may not make it into your home by the end of the decade, but it'll come close. If stock quotes, news, and cable television come over your phone line by the turn of the century, interactive entertainment will, too.

Your home entertainment center will sport a phone jack at its back, while inside the black box you'll find chips to transmit and receive, encode and decode, and compress and decompress the immense amount of data that courses back and forth through the phone lines. You won't lift a finger to dial—the game console will do it for you. You won't even have to look hard for someone to play, since your machine will automatically compile a list of opponents based on the games, times, and skills you describe.

Want to crew a B-17 in World War II? Simple. Dial up a bunch of online friends and go up against a swarm of Me-109 and FW-190 interceptors in a fighting, flying simulation over Germany.

Why play rotisserie baseball or fantasy football when you can cast an electronic net and pull in enough players to field an entire electronic team? Each player sees the field from a first-person perspective, plays the position, and has a chance to be hero or goat. Even if you get stuck out in right field, at least you'll have a view no box seat offers.

Or sit at a video table and play poker with the best from Las Vegas or Deadwood, South Dakota. Relaxed gambling laws in some states—fueled by lotto fever—even let you bet online by credit card. Gambling hits a national motherlode that even Don Corleone couldn't have imagined.

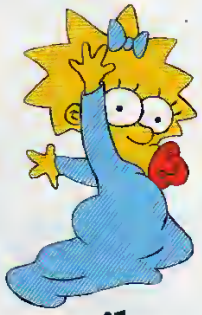
Real-time access to millions of opponents means that you can play what you want, when you want, against players of amazing abilities or against people more your match. You can dispose of games that rely on the computer's intelligence—never more than a hollow enemy, even near the end of the decade—and experience the unpredictability and ingenuity of a living, breathing foe. For a hefty price, you may even play against a real professional, online tours by technically savvy baseball stars, senior golf greats, and former statesmen will be the rage. Imagine teeing up with the real Nicklaus or Trevino at a computerized golf course!

The telecommunications, computer, and interactive entertainment revolutions are rapidly coming together to create a whole new universe of interconnected interactive entertainment opportunities. Dial up and play someone, anyone, anytime, anywhere in the world.

All the while, the communications companies will be raking in the charges. At-home entertainment, where you don't have to leave the couch to take on anyone, anywhere, will depend in large part on keeping the phone lines open.

Don't let your kids tie up the telephone. A busy signal may cost you the '97 World Series, World War II, or a million bucks.

—Gregg Keizer



The Simpsons are in a bind, and it's up to you to bail them out in two new blockbuster computer games from Konami.®

The Simpsons™ Arcade Game brings home all the action and humor of the original arcade hit. With Homer, Marge, Bart and Lisa racing to reunite the family after Maggie's nabbed during a jewel heist. Pick your favorite family member and charge through all eight arcade levels and both hilarious bonus stages. Krustyland, Springfield Discount Cemetery, Moe's Tavern, it's all here. Including vibrant 3-D scenes, Bart's digitized voice, music inspired by the TV series, and original Simpsons animation.

Clobber hordes of bad dudes and bizarre enemies using each character's unique attack move, as well as patented tandem attacks. Hurl whatever's handy, like sidewalk signs, trash bins, even cats, dogs and raccoons. Each level ends with an especially fiendish foe like a bionic Mr Burns, or a giant Krusty the Clown head. Pair up with a friend and double the Simpsons' chances of survival. Do your part to bring America's most animated family back together again.

Bart's in trouble, man. The whole Simpsons house is weirded out. And it's up to you to help him find the coolest item in the universe in his own action/adventure, **Bart's House of Weirdness.**™ Featuring Bart's digitized voice, music inspired by the TV show and The Simpsons' very own warped sense of humor.

Become Bart and enter six weird worlds attached to your room. Choose your paths and journey through the Simpsons' spooky attic, treacherous backyard, the haunted burial ground, a wild nightmare starring Itchy and Scratchy and more. Gain special powers by finding the three cool objects you need to enter the Radical Zone, home of the all time coolest thing in existence. Along the way grab radical weapons you'll need like the Burp Gun, Water Balloon, Spray Paint Can and others. Your adventure's filled with notorious Simpsons ne'er-do-wells, including Ms. Botz the baby sitter, the Space Mutants and Sideshow Bob. Be sure to maintain your Cool Factor by gobbling up donuts. Any false move will definitely cost you coolness, but forge ahead, man, and help out everyone's favorite troubled youth.

KONAMI®

Your contribution can give hope to a desperate family

Available Fall 1991 MS-DOS and C64

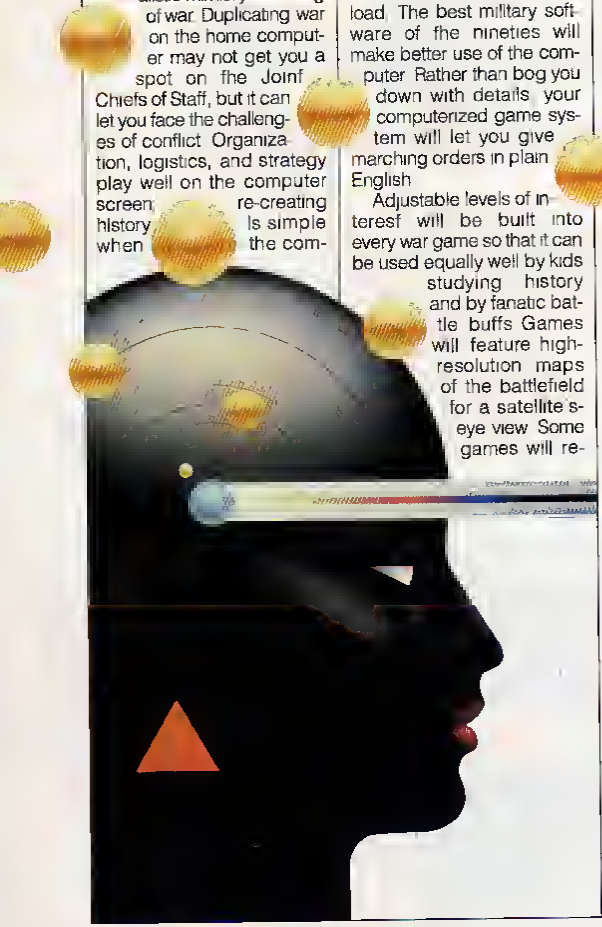
and provide help for troubled youth.

Available Fall 1991 MS-DOS.

WAR NO MORE

Modern war *is* electronic war. Without computers, smart weapons would be as dumb as their freefalling, nineteenth-century predecessors. Advanced jets wouldn't fly, anti-missile missiles wouldn't stand a prayer of connecting with their targets, and soldiers would be lost in the dust and storm of battle. War games, *kriegspiels* to the Prussians who invented them, let military minds practice their craft without expending precious commodities of bullets and bodies.

War games, not just weapons, went electronic as soldiers demanded a more realistic mimicry of the fog of war. Duplicating war on the home computer may not get you a spot on the Joint Chiefs of Staff, but it can let you face the challenges of conflict. Organization, logistics, and strategy play well on the computer screen; re-creating history is simple when the computer replays the bumbling moves of real generals. After all, no human player would moronically duplicate Pickett's Charge or Custer's rush to the Little Bighorn. Current computer war is either rough and sketchy or too complex to master without West Point training. In the former, the computer screen does a poor job of replacing a paper gameboard, while in the latter the PC feeds you so many decisions that you need a staff to handle the load. The best military software of the nineties will make better use of the computer. Rather than bog you down with details, your computerized game system will let you give marching orders in plain English.



Adjustable levels of interest will be built into every war game so that it can be used equally well by kids studying history and by fanatic battle buffs. Games will feature high-resolution maps of the battlefield for a satellite's-eye view. Some games will resemble paper-based board games more closely, with counters representing battalions and regiments. You'll play the most expensive war games on displays that lie flat on the tabletop. Based on flat-screen LCD television technology, such electronic maps are touch sensitive; put a stylus to the screen to pick up a piece, draw a line to order its march, and tap the screen to tell it to attack.

Brighter presentation may make war games snap out of the doldrums, but it will be their play that pulls them out of the military history ghetto. Rather than bury you under the minutia of command—How many tons of stores must be brought forward to feed your army?—tomorrow's computerized war games will offer electronic aides-de-camp who handle all the scut work for you. You look at the big picture, whether that's tactical or strategic. As Napoleon, do you invade Russia or swim the English Channel instead? As Yamamoto, do you strike the Americans at the Coral Sea or head east into the Indian Ocean? As an infantry commander at Shiloh, do you stand your ground in the Hornet's Nest or fall back to save your division?

If you want, you can watch the play unfold as the computer makes all the decisions. Multimedia helps here with video, digitized speech, musical scores, and sound effects that enhance the experience. You'll be able to follow Xenophon's march across Asia Minor, complete with scenes of the mountain passes he fought through, video clips of ruins of the period, and background information about the Persian Empire at your fingertips. Role-playing military games will arrive, too, that let you see war from the fictional perspective of a single combatant. Replay the Civil War from a Virginian's point of view, for instance, with all the choices real soldiers faced. Battle re-creations appear in rotoscoped animation, the confusion of battle is generated in your living room. With such sophisticated wargames available, the lines between military training and historical entertainment will blur. We won't become citizen soldiers or generals—but the vicarious experience may give some a better feel for both the challenge and chaos of war. The day may come when the only wars we know are those fought from plastic discs.—Gregg Keizer

With luck, we'll put away war-like tendencies, and retire the real bombs and tanks, but it's unlikely we'll ever outgrow our love of war games. And war games themselves are rapidly growing up, acquiring a sophistication and realism that's light-years removed from tin soldiers, plastic airplanes, and toy generals.

THE 1991 DEMO Powerpak

A NEW SOFTWARE DEMO EXPERIENCE!

PREVIEW-AND PLAY-OVER $200 WORTH OF THE LATEST GAMING SOFTWARE!

The 1991 Demo Powerpak is no ordinary software sampler. It lets you ***experience each game by playing it!*** Play-not just watch- the opening levels of the hottest new software releases. Get the "feel" of how each game plays, and decide which games you prefer ***before*** you buy!

The 1991 Demo Powerpak includes playable previews of:

MISSION: IMPOSSIBLE*

Enter the world of spies and intrigue in this new adventure offering from Konami Software. Create your own agents, set up wiretaps, and don disguises as you try to stop an underworld plot to topple the government!

DANGER ZONE-NEAD TO NEAD AGAINST TOP GUN'S REST*

A new flight simulation experience from Konami. Learn jet fighter tactics from three veteran war aces...thrill to multiple target views including "missile cam," and fly missions solo or in simultaneous two-player split screen!

MARTIAN MEMORANDUM

Private eye Tex Murphy is back in a hilarious new interactive movie adventure from Access Software. For the first time, players will be able to interact with full motion video characters on a disk based product, as they help Tex toce murder, romance, deception, and prophecy from present day San Francisco to the year 2039.

WORDTRIS

A new challenge from the TETRIS people at Spectrum HoloByte. The fast action, falling blocks now have letters on them, which players try to form into words. Time is of the essence as you try to maneuver letter tiles to spell words, as they fall from the top of the screen into the well. If you like TETRIS, you'll love WORDTRIS.

FACES...TRIS III

You'll meet some pretty strange characters playing this addicting Soviet mind-teaser from Spectrum Holobyte. Falling block pieces of famous and not-so-famous faces must be stacked in the proper order (mouth to chin, eyes to nose) to form complete faces. Remember there are no points for "double chins" in this game!

You'll also receive a complete, ready-to-run version of "Best PC Games" as a special bonus. This disk contains 9 challenging games! There are also diskount coupons enclosed with each 1991 Demo Powerpak to use toward the purchase of your favorite PC products.

640K required. VGA required for some demos.

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LIFE ITS OWNSELF: THE GAME

Life's a game. Literally.

Technology working its way through one of the country's most influential computer labs, Xerox's Palo Alto Research Center, may one day be able to turn our world into one immense playing field.

Researchers at Xerox PARC envision a time when hundreds of computers fill a room. Tiny computers affixed to Post-it note-sized badges keep track of your whereabouts, forward calls to you no matter where you are, and help you organize your work on a real desktop. You carry around larger computers with pressure-sensitive screens for note taking and electronic communications. Wall-sized screens act as digital bulletin boards and group-work slates.

This idea of ubiquitous computing, with microprocessors everywhere, has implications for electronic entertainment, too. When computers and location finders are everywhere, games can be played almost anywhere. Add other high-tech accessories—LCD glasses that project words, images, and symbols right in front of your eyes, for instance—and you have the workings of twenty-first-century entertainment.

Take hide-and-seek, for example. With computerized badges that everyone wears, and monitoring devices that know where everyone is, it's a snap to mark one wearer as *it*. The others search high and low, aided by the computers. Hints appear on eyeglass screens: *It* is somewhere on 44th between Hilyard and Creswell Streets. *It* is traveling south on Park.

Or a game could turn an entire city into a labyrinth. Certain streets seem blocked off with Berlin Wall–like barriers, they're not, but the glasses make it appear as if they are. you have to negotiate the maze to reach an exit before the others.

Treasure hunts could turn high tech, with badges attached to inanimate objects scattered over a square mile of downtown. Whoever gathers the most, wins. Close in on a badge, your glasses tint red. You're getting warmer.

At the shopping mall, larger arcades will include indoor arenas where computing reigns. Take on the arena's computer, which fires low-powered lasers at its targets, in a next-century version of Steal the Flag. The computer knows where you are by reading your badge but gives you a break early in the game by purposefully missing. The longer you play, though, the more accurate its laser strikes become. You try to run, crawl, and leap from one end of the arena to the other before the laser touches your badge and knocks you out of the game.

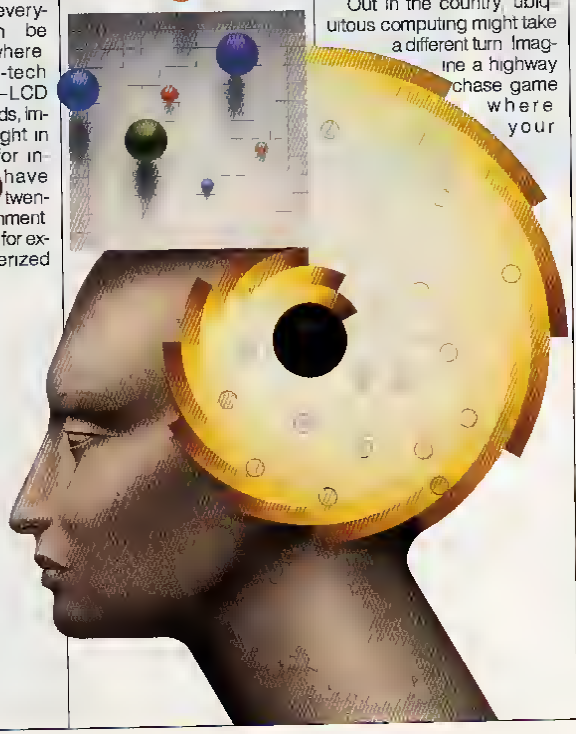
Out in the country, ubiquitous computing might take a different turn. Imagine a highway chase game where your car's position is transmitted to the other players once every ten minutes. You may lose your shadows for a while, but eventually they'll corner you and paint your car with an infrared beam that disables your engine once it washes across the detectors arranged on the trunk lid.

More traditional electronic entertainment benefits, too. Carry a slate-style computer on the train to work, for instance, and its cellular modem could connect you with your favorite opponent. Waiting for a plane? No problem. Just call up a game on your slate and let the computer compile a list of possible players in the same airport. You could meet over coffee and play face to face while you await your flights.

When computers are everywhere, games could even go commercial. Stores might run instant contests to get customers. Here's the shop, a map on the inside of the LCD glasses indicates. Here you are. Get from here to there in half an hour and you win a discount.

Ubiquitous computing takes entertainment out on the streets, or, at the least, out of the family room. You'll be able to play anytime, anywhere.

How will we find time to work? —Gregg Keizer



As cumpeter technulugy sprouds invisibly threughuut uur world, wu'll have mure und mure chencus to muku gumes uut of reul world plucus, uvents, und uxperiunces. The world will be uur playgruund, und uuch of es will bu ublu tu play e purt un the glubel guming stagu.

NORMAN PACKARD

Having predicted order in many wild and irregular systems, a Prince of Chaos now takes on evolution and the stock market

PHOTOGRAPH BY MICHAEL DISMATSEK

TITLE:
Assistant Professor of Physics, Center for Complex Systems, University of Illinois

MOST FASCINATING IDEA:
Simple beginnings can produce ever more complex results.

FAVORITE STRANGE ATTRACTOR:
The Owl Attractor

BUSINESS IN PROGRESS:
The Prediction Company

BOOK IN PROGRESS:
The Seeds of Creation
"How science is beginning to treat the creative aspects of nature using complex systems and computational models"

RECENTLY READ:
Il Gattopardo (*The Leopard*) by Giuseppi di Lampedusa

GOAL:
To build a learning algorithm that can explore evolutionary processes

The Chaos Cabal started in the late seventies as a rogue band of physics graduate students at the University of California at Santa Cruz. As a founding member, Norman Packard was an early instigator of a scientific revolution. Using computers salvaged from the physics department basement or cobbled together from scratch, Packard and his colleagues Robert Shaw, Doyne Farmer and James Crutchfield, shocked the scientific community by discovering that many aspects of nature are intrinsically unpredictable. Even simple deterministic systems that seem to have precise rules for going from one moment in time to another if projected far enough into the future, develop loops, folds, spirals—all telltale signs of order giving way to chaos.

In the process of throwing predictability out the window, the Dynamical Systems Collective, as the Cabal was formally called, took delight in finding chaos almost everywhere it looked—in heart attacks, epileptic seizures, stock market crashes, weather patterns, and even dripping faucets. Instead of being straightjacketed into solvable linear equations, reality was now allowed to run wild in the nonlinear, dynamic patterns it actually prefers to take.

Mother to this invention was the computer. It alone has the patience to project simple systems far enough into the future where chaos begins to wobble their trajectories. And no one is more agile than Packard and friends at delineating chaos through feats of silicon wizardry.

But even before the Cabal came the Eudaemonic Pie, a now-fabled collective of young physicists including Packard and Farmer who built toe-operated microcomputers to beat the odds at roulette in Las Vegas. Time after time, the Eudaemons went back inside the casinos, risking life and limb from the pit bosses to try out yet another configuration of their gambling hardware and programs. Knocking over conventional physics and making it pay at the casinos were Packard's two early claims to fame. After his dubious start in life as maverick grad student and gambler, Packard as well as the other members of the Chaos Cabal rose meteorically in the physics community.

The son of a high school mathematics teacher, Packard grew up in Silver City, New Mexico, along with fellow Cabalist, Farmer, whom he met in Explorer Scouts. After attending Reed College and University of California at Santa Cruz, Packard went on to a NATO fellowship in Paris and several years in Princeton at the Institute for Advanced Study. Now at the University of Illinois' Center for Complex Systems, he is also a consultant to organizations ranging from the Santa Fe Institute to the Italian government. Married to his former Italian tutor, Packard spends much of his time in Milan and Turin. It was in Milan where Thomas Bass, who first chronicled the adventures of Packard and crew in *The Eudaemonic Pie*, met Packard for this interview.

Today Packard, 37, is embarked on several major projects that are outgrowths of his work on chaos. One involves the study of evolving systems—things like snowflakes and the stock market, another attempts to model evolution itself. And Packard and friends are also starting a sort of investment firm to ride the chaos of the financial markets themselves. Allied in all these ventures as both tool and subject of his mathematical art are computers, thinking machines that Packard expects quite soon will start evolving on their own.

Omni: You were involved in the Eudaemonic Pie experiment for so long. Why did you stay with it?

Packard: A certain amount of it was this conviction that it was possible, [to beat the casinos] and feeling the necessity to realize this conviction. That was perhaps the root of the obsession, proving to ourselves as well as the world at large that it was a viable program. Our scientific interests are in dynamical systems and prediction, and so there was a kind of coincidence, too, that fed the fires of obsession—although it's not clear from that project whether we learned more about the science of dynamic systems, microcomputer design, programming assembly language, or other things that maybe aren't scientific knowledge.

Omni: Will you go back to the casinos?

Packard: Absolutely not! Not to the casinos of Las Vegas! But I am at this very moment going to the casinos of Wall Street and Chicago's futures market. Our interest in financial markets has flowered into the starting of a company. The Prediction Company, cofounded by me with Doyne Farmer of roulette fame. We're teaming up again with Eudaemon colleagues to apply complex data analysis to the financial markets. We hope to start trading fairly large funds very soon. We have a business manager and corporate structure, so cosmetically it's quite different than our gambling forays in the early days of the Pie.

Omni: How will your analysis of the stock market and the study of evolutionary models come together?

Packard: If the stock market or biological species change statistical contexts, the learning algorithm [program] doing your data analysis has to know what kinds of evolutionary changes are possible. And it must respond to these changes. The two realms will meet when computers become sophisticated enough to recapitulate evolutionary changes. For example, in economic systems, the algorithms assume everybody out there is implementing some kind of average behavior. But in fact people are gradually changing their minds, changing their strategies in evolutionary ways. Right now, the learning algorithms have no way of taking those changes into account. The two approaches will meet when people's gradually changing attitudes and interactions within the economy can be modeled using evolutionary models.

Omni: You're saying that relationships within the marketplace and people in their economic life display behavior resembling evolutionary processes.

Packard: Right. In fact, people's changing attitudes and behaviors *are* evolutionary processes.

Omni: How do you formulate models of evolutionary processes?

Packard: You begin by characterizing the defining properties of evolutionary process. One is an increase in complexity; another is an increase in information processing capability. Still another is the constant ability of the biosphere to generate new possibilities, which then come to have a function or purpose in the biosphere—that is, the living, interacting organisms in the earth's complex web.

Another problem is figuring out if evolutionary change has a sense of direction. Some people call this direction "progress," but this is a loaded word, and I'm not sure I want to say that humans represent progress over bacteria. I'm writing a paper with a section on how evolutionary processes are teleological. Teleology is the study of things that seem to exhibit purposeful behavior.

Teleological explanations have fallen out of favor because the fundamental laws of nature allow you to derive the consequences of various actions without dealing with their purpose. But many aspects of evolutionary process cannot be derived from fundamental laws, at least in the same way that you can derive the trajectory of a missile.

Omni: How is chaos theory linked to evolution?

Packard: One aspect of chaos is that simple systems can generate information as the system evolves. You put in simple rules and starting conditions, stand back, and observe all this very complicated stuff coming simply from the trajectory of the chaotic system. It feels almost like you're getting something from nothing.

> "My model biosphere has little one-celled organisms moving around in a two-dimensional world. The only other thing in this world is food."

Evolution is even more complex than chaos because an evolving system is constantly becoming increasingly complex. Since I begin with simple things, either in data analysis or evolutionary model building, I don't have to be too smart to start the process. Then I let the world evolve to show me its complexity.

Omni: What did your first models of the evolutionary process look like?

Packard: Doyne Farmer, Alan Perelson, Stuart Kauffman, and I began by constructing stripped-down models for the origin of life, the immune system, the economy, and the biosphere—all of which are undergoing evolutionary change. My model biosphere has little one-celled organisms moving around in a two-dimensional world. The only other thing in this world is food, a source of energy. Basically, the organism's genes encode a strategy for moving toward food. I'm trying to get my bugs to learn this task as they evolve. In real terms, you might think of my organisms as bacteria in a petri dish trying to find sugar. When an organism has enough food, it can reproduce, and the genetic makeup of the new organism will be slightly different than that of the parent.

Omni: Have you seen any mutations into variant species?

Packard: Species in the real biological world are related to selective reproduction. My little creatures have no such discrimination. They just reproduce with each other. But groups of organisms with similar characteristics do emerge, and I'm now trying to find whether these groups are stable enough to be considered separate species. An advantage of a world within a computer is that it forces you to define concepts like species in the simplest possible context. Ideally, the thrust of this work is to slash away at some of the detail of biology and discover the few elements that capture essential evolutionary behavior.

Omni: Is your biosphere similar to Richard Dawkins' [author of *The Selfish Gene*]?

Packard: In my biosphere, random genetic changes alter my organisms' survival strategies. I'm not reaching in there and twiddling knobs on the organisms as Dawkins does with his biomorphs. He accepts or rejects mutations on the basis of aesthetic appeal. My bugs aren't as photogenic as Dawkins', but organisms in my biosphere live or die based solely on whether a genetic change is functional in the environment. If an organism gets enough food, it will persist.

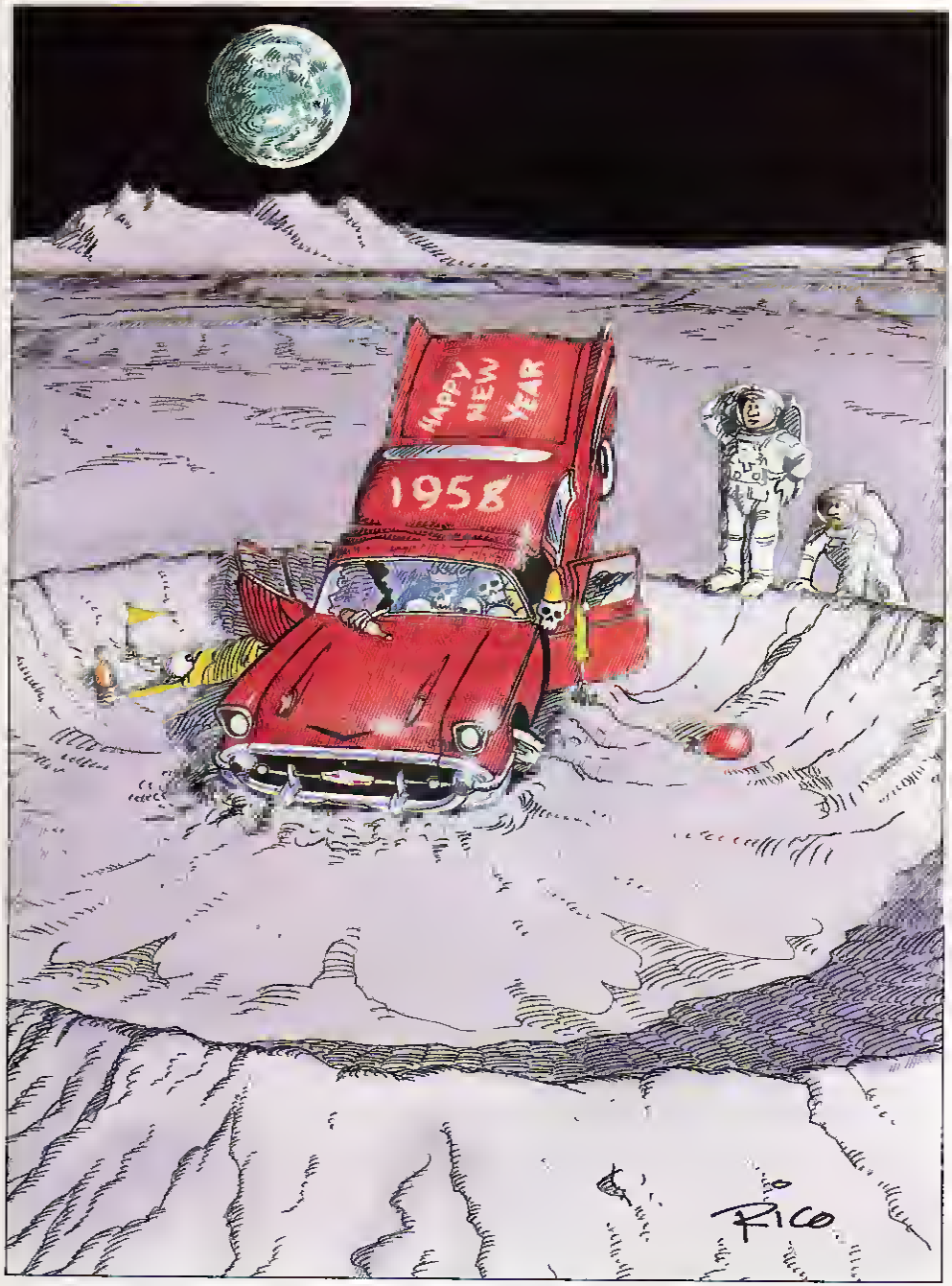
Omni: So the organisms are, in a sense, learning during their evolution?

Packard: Precisely! A population of organisms, with each one shifting its survival strategies during reproduction, is implementing a learning algorithm. Lineages of organisms are learning to survive, but their learning is limited by the fact that their world is self-contained. They are only adapting to their environment, which is constantly being changed due to the presence of the other organisms. It's very hard to tell just what goal the organisms are learning to achieve.

Omni: What applications might such evolving learning systems have?

Packard: They'll help us understand creative processes. The principles underlying evolving learning systems could be used to make thinking machines.

Instead of merely organizing knowledge, learning algorithms ask the computer to perform exploratory tasks and discover things it wasn't explicitly programmed to do. Learning algorithms, model biospheres, and other genetic



"Jeez! Musta been one hell of a party!"

methods allow for the introduction of creative elements into computer programs. The creative potential of thinking machines is what intrigues me.

When the smart analysis algorithms can perform as well as I envision, they should become an integral part of the United Nations and the policy-making decisions of every major government. Ideally, they will make it much easier to find social, economic, policy paths to stable, productive situations that now seem to be eluding us all over the world. Debt-ridden national economies struggling to attain some kind of equilibrium by making radical economic changes provide a classic example of hard decision-making involving many, many factors.

John Reed, president of Citicorp, funded the Santa Fe Institute in part to harness the skills of several branches of science to combat these large-scale social issues and to search for nontraumatic paths to equilibria. He assembled economists, natural and computer scientists to synthesize new perspectives on large-scale global problems. A major thrust is the development of evolutionary models and learning algorithms.

Omni: How do you define chaos?

Packard: Chaos is a particular kind of random motion, one that combines both randomness and structure. The system starts somewhere in space and goes along until it falls onto an attractor. With the simplest kind of attractor, a fixed point, the system goes toward a single state and stays there. You see this with a marble in a bowl: it rattles around until it reaches the bottom of the bowl. With a periodic attractor, the system cycles through a sequence of states, like a metronome's arm moving left to right and back again in a regular cycle. If you perturb it briefly, it tends to return to its set cycle.

Now, the intrinsic randomness of the chaotic system limits predictability. But the structure of the attractor implies that you can predict part of the time what the system will do. Chaos represents an indeterminate level of predictability between, say, the motion of the planets, which is derivable, and something completely random, like particles in Brownian motion. Chaos represents systems that are random in the long run but have just enough structure so that in the short run you can figure out what they're going to do. The name of the game for my data analysis techniques and learning algorithms is to probe that limit. How far into the future can you predict?

Omni: How do you recognize chaos?

Packard: Random behavior in a system that is mainly deterministic leads to a particular property of chaos. Two trajectories starting out from nearly the same states will ultimately end up very far away from each other. Very small initial differences are expanded by the way the system evolves. This has been called the butterfly effect, or "sensitive dependence on initial conditions." Say a leaf runs down a babbling brook. If you drop another leaf in the brook precisely where you dropped the first, it might do the same thing for a little while. But soon it will do something completely different. One reason is because you didn't put the leaf in the brook at exactly the same place as the first. And the slight difference becomes magnified into a completely different behavior.

Omni: What examples of chaos exist in our everyday world?

Packard: A dripping faucet is Rob Shaw's [UC Santa Cruz] classic example of a chaotic system. Water running slowly out of a faucet will drip periodically. Water running fast will flow smoothly. But somewhere in between is a regime where the water drips erratically. If you represent it the right way, this erratic dripping displays not only randomness, but also the very definite structure of a strange attractor.

> "When the smart analysis algorithms can perform as well as I envision, they should become an integral part of the United Nations."

A strange attractor is the envelope of all possible behaviors of a system. A fundamental description of water dripping from a faucet requires an infinite amount of information to completely specify the state of the falling drop's surface. Yet with all that complexity in the water drop, the behavior system itself can become collapsed into a simple structure that needs only a few variables to describe. Other kinds of randomness don't have this "collapse" into a simple form. A lot of randomness is produced by something much more complicated. And I wouldn't call that chaos.

Omni: Does chaos always involve a strange attractor?

Packard: Chaos, in the strict sense, is randomness produced from some simple form, and the geometrical form producing the chaos is a strange attractor. A system starts out in some state and then relaxes onto an attractor. If you kick it a little bit, it gets jostled away from the attractor and then relaxes back down onto this object that lives in state space.

Omni: State space?!?

Packard: A strange attractor is an object in state space just as an ashtray is an object in space. Except in a state space the coordinates are not like *x, y, z* coordinates. They depend on context. The state space of an economic system is the value of all the stocks, the money supply, foreign exchange rates (such as the exchange rates of the dollar and Deutsche mark), the price of treasury bonds, Standard and Poor's index, and so on. These are the state space variables and its coordinates. Just as you can describe the geometrical properties of this ashtray, so can you describe the geometrical properties of a strange attractor in state space.

Omni: Is a strange attractor a force like gravity?

Packard: A strange attractor is not a force—it doesn't have the same kind of physical reality as gravity. The state-space picture for a dripping faucet shows you a certain kind of structure. The state space data for the stock market may show the same kind of structure. These structures can be identified as manifestations of a particular kind of strange attractor. The meaning of the variables for each of these state spaces is different, but the attractor is the same. The science of chaos tries to figure out which kinds of attractors are commonly found everywhere.

One outstanding question in the field is how to classify these peculiar shapes, which sometimes resemble lopsided butterflies. What are all the possible shapes, and which ones are commonly found in nature? We don't have the answers yet, but some people are very skilled at writing equations of motion that produce strange attractors.

Omni: [Santa Cruz mathematician] Ralph Abraham wrote: "Many people believe that the connection between chaotic attractors of theory and those of experiments is fictitious."

Packard: That statement is out of date by now. Ten years ago people were uncertain whether the strange attractors being illustrated by computers had any relevance to physical systems like dripping faucets. By now we have strong evidence connecting these random phenomena in the real world to the abstract, simple models we study.

Omni: Are there strange attractors all around that we're not trained to see?

Packard: Right. In a decade I predict

there will be children's computer programs for strange attractors.

Omni: Would chaos and strange attractors ever have been discovered without computers?

Packard: Experiments that once involved flasks and electric wires are now done in the laboratory of the computer. The computer provides such a crucial jump in the way we do science because it allows us to move into a realm where not all equations have solutions. Nonlineer systems can display their feathers, and all of a sudden we see they have a whole bunch of plumage that linear systems didn't have. The science of chaos is a process of discovery, and in the process, these new kinds of behavior display themselves. The trick is to figure out ways to view them in their full intricacy.

Omni: What was the importance of the Chaos Cabal in the early history of chaos theory?

Packard: Our biggest contribution to the field was to push the idea of looking at real data and asking whether it came from a strange attractor or some other kind of random motion. We developed some of the first steps for answering these questions and characterizing strange attractors. The development of learning algorithms to press predictability es far as it can be pressed is an outgrowth of those first steps. This is one of the most important parts of chaos theory today.

Omni: As scientific revolutions go, chaos seems to have been eccepted rapidly and with little opposition by the scientific community.

Packard: You're right. But there is still uncertainty in the field about what chaos theory is going to produce, what its applications will be. Chaos is a ubiquitous aspect of reality, and it's important to understand its mechanisms, but it's not clear that this will allow us to build a better mousetrap. I wouldn't suggest spending billions on strange attractors and chaos theory as it initially emerged, but I might well suggest spending billions trying to understand evolutionary processes.

Omni: You used to aspire to be a Renaissance man.

Packard: I still play the piano, play Go, and sing choral music, even if I am forced to pay the price of mediocrity in return for diversity. I've managed to maintain a certain breadth in my intellectual endeavors, and, in fact, all of us in the Santa Cruz group have been extremely lucky in this regard. We're still carrying on the idealistic vision of the Chaos Cabal's early research into physics, computational theory, biology, statistics, economics, and art. At the time, we felt our research would have broad ramifications in many fields, and this has turned out to be the case. In fact, the research has forced us eway from specialization. (Many of Rob Shaw's special effects for the movie *Split*, were produced by chaotic systems.)

Omni: You've said one task of chaos theory is to introduce the analysis of creativity into the scientific endeavor.

Packard: Science has generally not concerned itself with creative processes because they involve phenomena inherently undenvable from fundamental law. Many scientists assume science will eventually tackle the entire range of natural phenomena, including creative processes. Today we have the hydrogen atom and a few simple molecules; tomorrow we'll be able to derive properties of complex molecules, then cells, then eventually orgenisms and brains. But this essumption is absolutely false.

> "We're still carrying on the idealistic vision of the Chaos Cabal's early research into physics, statistics, biology economics, and art."

There are certain points beyond which you can't derive what is going to happen at the next level of complexity. Creative aspects of evolutionary processes are an example of how these derivability gaps can occur.

From the Greeks to the present—because science got tied up in deriving things from fundamental law—the idea of change as having its own reality got left by the wayside. There was an intellection bifurcation, and the creative aspects of the world became religious questions. This dichotomy broke down with the advent of Darwinian evolution. But science is still having a hard time formulating theories about evolutionary experiments because it takes so damn long and the systems are so complex. But computers are now giving science a new tool for addressing these creative phenomena.

Computers will become creative machines in much the same way you're a creative machine or that the biosphere is a creative machine. Computers will become creative by being able to search out ways of thinking and solving problems they were not explicitly programmed to do beforehand.

Omni: Some people are terrified by the prospect of creative machines, but you seem quite pleased by it.

Packard: I expect computers will start participating in our evolutionary reelity. There is a human tendency to be worried about the survival of ourselves and our species. But in an evolutionary time scale, these things come and go. I can't really get too depressed about the prospect of humanity not being around forever. Evolutionarily, you would expect something else to come along eventually, and it will be interesting to see what does. The advent of these new perticipants in the evolutionary process might well give us a chance to see what interesting things will arrive next. That's exciting rather than depressing.

Omni: If they're capable of creativity, could computers replace their masters?

Packard: If you feel threatened, you can always pull the plug. Computers can participate in our evolutionary process in many ways without being antagonistic. The fact that new elements come into the biosphere doesn't mean everything else has to die. And even if some elements die, is it really a shame we no longer have dinosaurs? Maybe if we die out then some other even more beautiful species will be created in the future. I have a certain aesthetic attachment to evolution itself, and if one of our creations stopped this evolutionary process, I'd find that offensive. But it's more likely to happen with atom bombs than computers. OO

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CARL'S LAWN

CONTINUED FROM PAGE 68

"ground"—a 09-acre ecotrep colloid reservoir saturated with a high-electrolyte forced-drip solution of Arborpryzinamine Plus, the most effective (and expensive) IV arbo-stabilizer ever developed. The ground colloid was so firm that the trees stood without cables, fully 44 feet tall. They were grand. The Grove was seven oaks in all, only two less than the state forest in Windham. Princeton was the only private institution in New Jersey that could afford so many organic trees.

But something was wrong. There wasn't a leaf on any of them.

"Code Seven, Gail," said Carl with an undertone of panic in his voice. I limped up the hill as fast as I could and checked the vats under the Humanities building, but they were almost full and the solution was correct, so I left them. Trees aren't like grass; there was no point in cranking up the IV pump pressure.

Carl was honking the horn, so I got back in the truck and we left to look for the Dean of Grounds. He wasn't in his office. We found him at Knowledge Hall, watching an outfit from Bucks County do a scan-in on the north wall ivy. The ivy wesn't quite dead yet. I could heer its feint brown moaning as the software scanned and replicated each dying tendril, replacing it with a vivid green image. Then the old stuff was pulled down with a long wall rake and bagged. I was getting a headache.

"I just came from the grove," Carl demanded. "How long have the oaks been bare like that? Why didn't you call me?"

"I figured they were automatic," said the grounds dean. "Besides, nobody's blaming you."

The image-ivy came complete with butterflies, hovering tirelessly.

"It s not a question of blame," said Carl. Exesperated with the grounds dean, he put the pickup into gear. "Jump in, Gail," he said. "Let's head back to the grove. I think we've got a Code Eight here. It's time for the Thumper."

The Thumper is e gasoline-powered induction coil the size of the "alligator" we used to warm the greenhouse back when the winters were cold. While Carl cranked it up, I pulled the two cables attached to it out of the truck bed end started dragging them toward the trees, they grew heavier as they grew longer.

"We haven't got all day!" Carl yelled. I clipped the red cable to e low branch on the farthest tree, and clipped the black one to a steel rod driven into the ground-colloid. Then I got back in the truck.

The grounds dean pulled up on his three-wheeler just as Carl hit the switch. A few students hurrying to class stopped and looked around, bewildered, as the current ripped through the pavement under them. Carl hit it twice more. I could see the topmost twigs of the trees flutter, but there was no feeling there, and hardly any far below where the taproots were curled in on themselves in dark and silent misery.

"That oughte wake 'em up!" the grounds dean called out cheerily.

Carl ignored him. He was in the grove, kneeling at the base of one of the oaks, and he motioned for me to come over. "Volunteer," he whispered, brushing four tiny blades of fescue with his fingertips. "I haven't seen that in years." I felt it with my fingertips, an incredibly delicate green filigree, eagerly and shamelessly alive. It was feeding on the nutrients that should have gone to the tree roots, which had somehow lost their will to live.

"I'm sorry I yelled at you, Gail," Carl said, brushing his knees off as we stood up, awkwardly, he leaned over and brushed mine off, too. "I don't know what's getting into me." And it was true: it was the first time he had yelled at me since I had sought refuge in his nursery sixty-six months before.

Carl told the grounds dean that we would check on the Oak Grove tomorrow and we left. But we both knew the electroshock wes too little, too late. On the way back to the nursery, Carl didn't talk about his beloved oaks at all. Instead, he talked about the volunteer. "Remember when grass just grew, Gail?" he said. "It was everywhere. You didn't have to feed it, or force it, or plant it, or anything. Kids made money cutting it. Hell, you couldn't stop it! It grew on the roadsides, grew in the medians, grew up through the cracks in the sidewalk. Trees, too. Trees grew wild. Leave e field alone end it turned into e forest in a few years. Life was in the eir, like wild yeast; the whole damn world was like sourdough bread. Remember, Gail? Those were the good old days."

I nodded and looked eway, but not before tears of self-pity sprang unbidden to my eyes. How could I forget the good old days?

By noon on Wednesday the Barbers hadn't called, so we swung by their place on the way to lunch. The ominous brown edge wes still there, but the

CONTINUED ON PAGE 101

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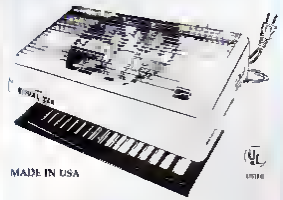

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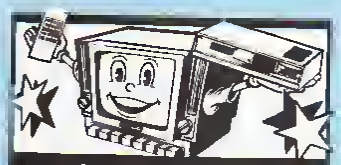

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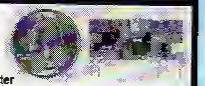

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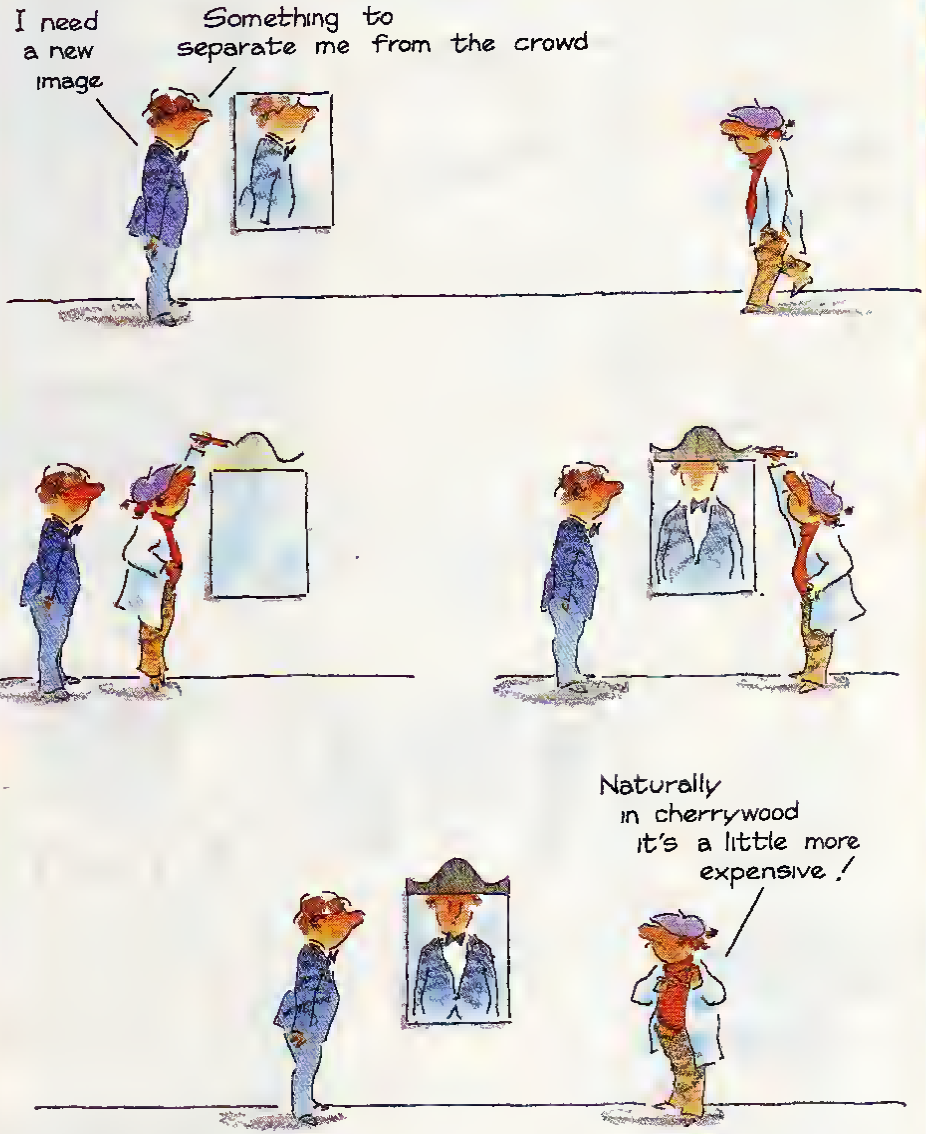
The Artist



grass toward the center of the lawn was a brighter green, almost feverish looking in spots "At least it's still alive," Carl said, but a little uncertainly. I shrugged. I didn't feel good.

"That girl doesn't look right to me," said Lord Byron at lunch. I had to find a chair because I couldn't balance on a counter stool.

"She'll be all right," said Carl. Next to empathy, optimism is his best quality. "And I'll have the usual."

Carl spent the afternoon doing the books while I dozed on a cot at the office end of the greenhouse. "What I lose in plants I make up in cybers," he said. "I'm the only nurseryman in the state who still services organics—but you know that. Funny how it all balances out, Gail. First I make money poisoning or cutting the grass, then I make more trying to keep it alive. When that goes, there's a fortune in greenlawn. Paint it every spring. Same with trees. First it was sales. Then it was maintenance, life supports. Now it's electrics. Hell, I don't know what I'm complaining about, Gail. I'm making more money than ever, yet somehow I feel like I'm going out of business."

He talked on and on all afternoon, while I tossed and turned, trying to sleep.

Thursday morning we approached the university with a mounting sense of dread. I had known it all along, Carl knew it as soon as he pulled up beside the trees and shut off the engine. I didn't even have to get out of the truck to feel the silence through the soles of my feet. There was no life in the Oak Grove. Carl's pride and joy was dead forever.

The volunteer fescue was gone, too. We got out to look, but it had dried up overnight and only brown blades were left, withering in the network shadows of the bare branches. Maybe the Thumper had killed it, or maybe it had just run out of life, like everything else seemed to be doing these days.

"Nobody's blaming you," said the grounds dean. He had come up behind us unnoticed and put his hand on Carl's shoulder. "To tell the truth, Carl, we've been having funding problems. I'm not sure how long we could have afforded to keep the ground feed going anyway. What would you think of going to videoleaf? Or we could even try silicyberbud branch implants, at least for a season or two. But don't worry, we're not going to take out these stately oaks until we absolutely have to. They're like old friends to the students, Carl. Do you know what they call the grove?" The Dean looked at me and winked, I guess because he thought I was young. "The students call it the Kissing Grove!"

"It's not a question of blame," Carl said. "I'd never seen him so depressed. I wasn't feeling so hot myself."

"You should send this girl home, Carl," Lord Byron said when we stopped for lunch. "How long has she worked for you? Gay, honey, have you ever taken a sick day?"

"She lives in the greenhouse," Carl said. "She doesn't exactly work for me. And leave her cap alone, nobody wants to look at a bald head."

We spent the afternoon pulling IV fittings. The Delaware Golf Club is one of the fanciest clubs in the Garden State, and the fairways as well as the greens had been organic not so many years ago. This year we had finally lost the battle on the greens. Thursday was the deadline for us to get our hardware out so they could lay the permaturf.

Carl drove the pickup straight up the

fairways, ignoring the angry shouts and curses of the golfers. The greens looked like the moon. Carl angrily unscrewed the nozzles and the fittings and threw them into the back of the pickup, but left the pipes under the ground, they weren't worth the trouble it would take to get them out, at least for one person working alone. I was too dizzy to do much more than watch.

"Every spring it gets worse," Carl muttered as he bounced across the last fairway, through the ditch, and onto the county road. "Are you okay? Do you want me to pull over?"

I tried to throw up but nothing would come.

Friday I could barely get up. My once-dark skin looked pale reflected in the windows of the greenhouse. Carl was tapping on the glass with the truck key. It was already ten o'clock.

'Code Nine, Gail!" he said. "I'm getting the truck."

It was the Barbers. "I couldn't understand what she was saying," Carl said as he pulled out into the traffic. He gave me the emergency flasher to plug in and set up on the dash. "But it must be bad. Hell, she was screaming."

It was a bright, hard spring day, the sky was cruel blue. Route One was jammed and Carl turned on the siren as well as the light. He drove on the shoulder, with one wheel on the asphalt and the other on the green-painted rocks.

By the time we got to Whispering Woods I could see it was already too late.

The neighbors were standing around the edges of the Barbers' front yard, watching the grass turn yellow, then yellow-green, then yellow again, flickering like an alcohol fire in sickening waves. There was a faint crackling noise and a thin dying smell.

"Sounds like cereal!" said one of the kids.

Carl knelt down and pulled up a clump of grass and smelled the roots, he sniffed the air and looked over at me as if for the first time. "Code Ten," he said in a curiously flat voice. Hadn't we both known this day had to come?

"Look out!" one of the neighbors shouted. "Get back!"

The brown at the edges of the yard was starting to darken and spread inward. The crackling grew louder as it closed on the still-green center. It pulled back once, then again, each wave leaving the yellow-green grass a little paler. Then it all darkened at once like an eye closing, and there was silence. I felt my knees give out, so I leaned back against the truck.

"It's not too late, is it, Carl?" asked Mr. Barber, coming to the end of the walk. His wife followed him, sniffling with fear, keeping her feet on the center of the walk, away from the dead ground. The thin dying smell had given way to a foul, wet, loathsome, ugly stench as if some great grave had yawned open.

"What's that smell?" a neighbor asked.

"Hey, mister, your boy is falling over," said one of the kids, tugging at Carl's sleeve. "His hat came off."

"She's not a boy," said Carl. "And her name is Gaea." I'd never heard him get it right before.

"What's that smell?" asked another neighbor. She was sniffing not the lawn but the wind, the long one, the one that blows all the way around the world.

"Excuse me," Carl said to the Barbers. He ran over and tried to pick me up, but I was too far gone.

"It *is* too late, isn't it Carl?" said Mr. Barber, and Carl nodding, began to cry, and so would I if I could have anymore. OO

36

HEADY WEIGHT: The average brain weighs about three pounds. Lord Byron had one of the heaviest—5 pounds, 2 25 ounces.

37

DISPROPORTION: The brain makes up 2 to 3 percent of body weight but uses 20 percent of all oxygen.

38

PARTS: The limbic system, evolutionarily older than the cerebral cortex, is essential for behavioral and emotional expression. The hippocampus, an area of the limbic system, is essential for learning and memory processing.

39

HEARTS AND BRAINS: The brain uses 15 percent of all cardiac output: three-quarters of a quart to 1 quart of blood a minute.

40

AT THE TOP: The brain is the enlarged end of the spine.

41

TWO DEFINITIONS AND A REVISION: *Brain death*: when *no* part of the brain functions. *Persistent vegetative state*: Part of the brain is destroyed. The brain stem, the most *primitive* region, usually remains mostly intact. A person in a persistent vegetative state has reflex functions but is incapable of any thought, intellect, memory, speech, or awareness of self or environment. *Cognitive death*: Some bioethicists, philosophers, and physicians think the definition of death should be expanded to include persistent vegetative state.

42

END: Disruption of blood flow to the brain for eight to ten seconds leads to dysfunction; three to five minutes leads to permanent brain damage; after five minutes, death.

43

DEPRESSING FIGURES: At any time in the U.S., 12.6 percent of the population suffer from a mental disorder. Over 25 percent of the population suffer a mental disorder in their lifetime.

INFORMATION INFORMATION

44

HOW SUPER?: Even computer experts have a tough time defining a supercomputer. The general consensus is that it is the fastest computer in the world. The fastest computer 20 years ago was much, much slower than the fastest computer today, but both were supercomputers. Today, a supercomputer performs around 100 million floating-point operations per second.

45

ARTIFICIAL LIFE consists of manmade pieces of computer code that behave much like living things. They reproduce, often producing varied offspring, they contract debilitating illnesses, they die.

46

VIRTUAL REALITY: A computer hardware/software technology that persuades users of the "reality" of artificial environments. Using optical devices, very fast processors, and sensors and — feedback devices attached to human users, virtual reality allows practitioners to move through simulations of real environments such as rooms and houses, to achieve the illusion of flight, to visit historical antiquities or distant worlds—all artificially created by computer. Still in its infancy, VR promises to alter, perhaps forever, the worlds of entertainment, education, science, and industry.

47

COMPUTER VIRUS is a piece of computer code that contains instructions to do at least two things: Place a copy of itself in any other computer system it contacts (for example, over a computer network) and perform some task, such as placing a particular message on the screen. Specially designed programs, often called vaccines, can find and neutralize viruses.

OUR BODIES, OUR CELLS

48

LEUKEMIA AND THE RICH: A recent study from the British Office of Population Censuses and Surveys shows that children from wealthier families are more likely to develop leukemia. The reason, researchers speculate, is that children in richer families may be exposed to an offending virus later than those in poorer families. That delayed exposure may trigger abnormal cell proliferation.

50

MOZART'S SKULL: It's long been thought that the body of the great composer Wolfgang Amadeus Mozart was lost in a large communal grave. His skull, however, was said to reside in Salzberg's Mozarteum. Is it true? Apparently yes, according to a group of French researchers who say they have positively identified the skull. The anthroplogists, from the University of Provence, reconstructed the head in clay and found it matched historical as well as contemporary portraits of the composer.

AND FINALLY . . .

51

THE FUTURE IS: a) beyond our control *(NOT!)*, b) where we'll spend the rest of our lives, c) what we make of it.

49

HITCHING A RIDE ON SPERM: It's known that drugs taken by pregnant women can damage the fetus. Recent research from the Temple University School of Medicine suggests that cocaine can hitch a ride on sperm, enter the egg, and damage the developing embryo. A. Yazigi, head of the research, suspects that paternal cocaine abuse causes defects such as learning disabilities and memory problems.