OMNI

JUNE 1989

DOLPHINS THAT TALK

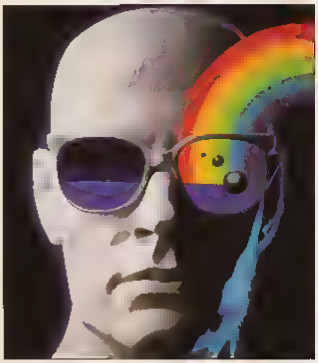
WHY LSD STUDIES WERE STOPPED

DIARY OF A CAVE WOMAN

THE VANISHING LEPRECHAUN AND OTHER MIND GAMES

OMNI®

VOL. 11 NO. 9 JUNE 1989



Three artists collaborated to produce the portrait of a literal spaceman on this month's cover. Filmia AB, a Swedish firm, designed the image using art by Torkel Henriksson, special effects by Unichrome, and a photograph by Lars Lie.

OMNI (ISSN 0149-6711) is published monthly in the United States and Canada by Omni Publications International Ltd., 1965 Broadway, New York, NY 10023-5965. Second class postage paid at New York, NY and at additional mailing offices. POSTMASTER: Send address changes to Omni, Magazine, Post Office Box 3041, Harlan, IA 51537-3041. Volume 11, Number 9.

FIRST WORD

By Charles L. Whitfield

"People are beginning to find their true identities by recognizing themselves as adult children of troubled families, by working on their recoveries in self-help groups, and by grieving previously ungrieved losses."

What is the human condition? Research from several professions is beginning to help us clarify this often-confusing term. Clinical professionals are focusing their attention on the "true self" or the "child within." It is believed this personal identity is critical to understanding behavior. To unravel the concept of the true self, researchers are studying how the family affects each individual.

According to Virginia Satir, a founder of family therapy, about 95 percent of U.S. families are dysfunctional—troubled unhealthy, or unable to deal directly with daily problems. Most households are troubled because the parents came from unhealthy families. Until someone breaks the cycle, parents pass on this painful legacy.

I believe that the primary cause of a dysfunctional family stems from the loss of each individual's "true self." This loss is an underlying factor responsible for several types of addictive or compulsive disorders such as alcoholism and other drug dependencies. More recently recognized problems associated with the loss of the true self include eating disorders, compulsive gambling, religious addiction, workaholism, mental illness, and family violence.

From the second we are born we have needs. These needs are healthy and normal. In a healthy family the parents are able to get their own needs met in a healthy way. The parents are then capable and free to provide many of the child's needs. They also act as models for the child, helping the child learn how to meet his own needs. The more wounded the parents and the more troubled the family, the less the child will be able to get his needs fulfilled.

Inside each of us are a variety of subpersonalities (the hero, the victim, the nurturer) that contribute to how we respond to life experiences. The two that are most central to either a healthy or an unhealthy development are the "true self" or the "child within" and the "false self." The false self is who we pretend to be. It allows us to survive mistreatment or neglect from within or, later, outside the family.

Growing up in a troubled family wounds the true self such that to survive, it goes into hiding and the false self (important only as an aid to some life experiences) dominates our behavior. This is the only way many people learn how to survive. A dysfunctional family does not support a child that exhibits his true self. The child is humiliated or punished and thus forced to react to life only through the false self.

I believe once wounded, the true self goes into hiding and the false self emerges to help the child survive. The child within still has needs, and from time to time the true self will peep out or show itself fully through an unhealthy explosion—a binge or compulsive behavior—often hurting the child or someone else.

So how can adult children of unhealthy families reverse their fate and get their needs met? Millions of people are beginning to discover their true identities. They are healing their child within by recognizing themselves as adult children of dysfunctional families and by working on their recoveries in self-help groups such as Adult Children Anonymous. Recovery is also obtained by grieving previously ungrieved losses, hurts, or traumas, which up until now may have kept these people locked into a life of unhappiness and compulsion.

The healing process has two powerful results. First, individuals will know themselves better and feel more alive, fulfilled, and creative. Second, they can then pass this aliveness, fulfillment and creativity on to their children.

The majority of individuals currently seeking this healing process are between thirty and fifty years old, and one in ten people receiving help is over fifty years of age. As the movement continues, more elderly will have found their true identities, thus providing a larger healthy support group for our children and grandchildren.

As society progresses and the nuclear family changes (through divorce, homosexual parents, and single-parent families), additional stress will affect each individual. The rising divorce rate, however, is often a mixed blessing. While kids ideally need both parents, if one or both parents aren't healthy, it is better for the child to grow up with the parent who is less wounded.

The loss of the true self is the human condition. It has been with us since the beginning of human development. I feel it is our basic dilemma. Should we be real, or should we be false? The movement to heal the child within has accelerated in recent years as a result of the growing awareness among helping professionals guiding more and more patients through the healing process in individual and group therapy.

Through this movement of self-caring and self-healing, the future of the family—in the midst of its apparent chaos—is indeed hopeful. Parents of the present and the future who heal themselves will be breaking the vicious cycle of passing their dysfunctions on to their children. Rather than teenage pregnancy and suicide, addictions, corruption, and crime at all levels of society, we may begin to see more wholeness, creativity, harmony, and peace on this earth. ∞

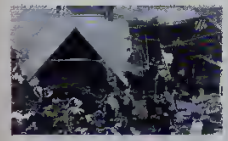
Charles L. Whitfield, M.D., is the author of the best-selling book Healing the Child Within. *His new book,* A Gift to Myself, *will be available in the fall.*

WAS IT JUST COINCIDENCE?

Or did Wendy Foster really foresee a disaster.

On October 21, 1966, Wendy Foster had a sudden horrible vision of a black mountain moving and children buried under it. At almost the exact same time in nearby Aberfan, Wales, a half million tons of black coal waste avalanched down, burying a schoolhouse and killing 116 children.

Evidence of ESP? That the mind is powerful enough to predict the future? Or should the incident be dismissed as mere coincidence? Now you can decide for yourself in MYSTERIES OF THE UNKNOWN, an eye-opening new series from TIME-LIFE BOOKS that explores the entire range of paranormal phenomena. Never before has such a distinguished



Rescue workers search the schoolhouse for survivors in Aberfan, Wales. From the volume *Psychic Powers*

publisher taken so comprehensive, authoritative, and objective a look at the unknown—to give you a well-balanced, unique perspective filled with the latest facts and firsthand reports, including the viewpoints of both psychics and skeptics.

WAS IT ONLY A DREAM? Or did Robert Monroe really have an out-of-body experience.

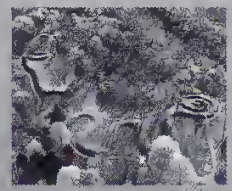
The 43-year old businessman first dismissed the odd bodily sensations as cramps. A month later, the vibrations returned and Robert Monroe awoke from his sleep, only to sense something smooth and cold against his shoulder. It was the ceiling. Looking down, Monroe noticed two figures in the bed: his wife and—himself!

Is astral projection a reality? Or just a product of wishful thinking? In MYSTERIES OF THE UNKNOWN you'll investigate intriguing firsthand reports and laboratory findings on out-of-body experiences, near-death experiences, and reincarnation.

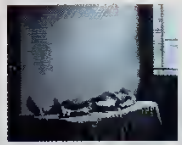
WAS IT JUST IMAGINATION? Or did William Horvath really sense an otherworldly presence.

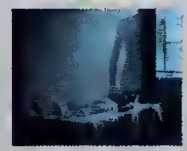
In November, 1975, sociologist William Horvath visited the Great Serpent Mound of Ohio. Standing on the ancient Indian earth sculpture, Horvath was overwhelmed by a sense of dread. Although there was no wind, he watched as one by one, the leaves gathered into groups and began creeping toward him, rising and falling like footsteps. . .

Do some spots on earth possess inexplicable powers? Find out in your first volume, *Mystic Places*. You'll explore the secret energies of Stonehenge and the Great Pyramid. . .



The Great Serpent Mound of Ohio: Is it haunted? Is it sacred? Is it a landmark? Find out more in *Mystic Places*.





People all over the world have detailed their out-of-body experiences. Read about them in *Psychic Voyages*.

Stonehenge
Poltergeists
Telepathy
The Bermuda Triangle
UFOs
Astral Projection
Mind Over Matter
Shroud of Turin
Clairvoyance
Channeling

discover the mysterious purpose of earth drawings in Peru . . . even examine scientific evidence for Atlantis. Your next volume, *Psychic Powers*, will bring you inside stories on enigmatic figures like Edgar Cayce . . . the Sioux shaman Black Elk . . . and Wolf Messing, mind reader for Freud and Einstein. In *Psychic Voyages* you'll discover why and how the spirit may sometimes leave the body—in remarkably consistent reports from all over the world.

Then probe the mysteries revealed in *Phantom Encounters, Visions and Prophecies, The UFO Phenomenon, Mysterious Creatures* and other volumes. Receive one about every other month and enjoy it free for 10 full days. For every volume you keep, pay just $12.99 ($16.99 in Canada) plus shipping and handling—an exceptional value for a beautiful hardcover book. You never have to buy a volume you don't want, and you can cancel anytime. You even enjoy one of the most extraordinary book guarantees ever (see coupon below).

Is there something beyond everyday reality . . . or should the evidence simply be dismissed? To get the facts, just return the coupon today. Then *you* decide.

When you send in the coupon for MYSTERIES OF THE UNKNOWN:

You're under no obligation. There's no minimum number of books to buy. Take 10 days to examine each volume before deciding.

Cancel whenever you like. If you don't want to examine any more books, just let us know.

You also enjoy an extraordinary guarantee. If at any time you're not happy with a book you've bought, simply return it for a full refund.

And of course, you'll be on your way to collecting the most comprehensive library to date on the subject of paranormal phenomena. Every page is beautiful, authoritative, fascinating.

Each handsome hardcover book contains more than 200 illustrations, including original full-color art, rare photographs, maps and drawings.

The stories described are real, but some of the names used here have been changed to protect the privacy of their owners.

Enter the realm of the unexplained with *Mystic Places*—yours free for 10 days.

Yes, I would like to examine *Mystic Places* free for 10 days. Also send me future volumes under the terms outlined above.

With TIME-LIFE BOOKS's Unconditional Guarantee of Satisfaction you can return any book you've bought, anytime, for a full refund. No questions asked.

D7CLP1

Name

Address Apt.

City State/Province

Zip/Postal Code

All orders subject to approval. Price subject to change.

New from TIME LIFE BOOKS

MYSTERIES OF THE UNKNOWN

A SERIOUS LOOK AT A WORLD THAT CAN NO LONGER BE IGNORED.

CONTRIBUTORS

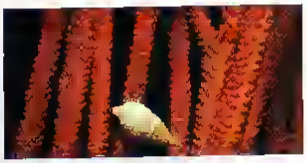
OMNIBUS

ROAD TO POWER

KAPLAN

KEATING

CAVE DWELLER S CHRONICLE



A WORLD OF CORA HARMONIES

THE DAY OF THE DOLPHINS

Some 8,000 years ago our human ancestors moved out of the caves gradually developing newer and greatly improved living shelters. It all led, of course, to superskyscrapers towering amid the clouds, climbing higher and higher above the subterranean world. Now we want to go even farther—into deep space. But in early January of this year an Italian interior designer abandoned modern shelters and moved back into the bowels of the earth. At this time the twenty-seven-year-old Stefania Follini is still living a solitary existence. Her only contact with humans has been through a computer, although a medical research team has constantly monitored the woman by video camera.

When writer *Alcestis Oberg* first heard about Follini, she tracked down the pioneering Italian and her research team. The result, a series of exclusive interviews with Follini conducted before and during the experiment and recorded in "A Cave Dweller's Chronicle: Fifty-six Days and Counting" (page 50). Through ongoing physiological and psychological tests, Oberg says, the team is studying the changes that occur during isolation "in a situation where a person is denied sunlight and a sense of time." Why? In part because the underground experiment will shed some light on long-term space travel, whose conditions are similar to those of cave life.

A regional finalist in NASA's defunct journalist-in-space program and the co-author of *Pioneering Space: Living on the Next Frontier* (McGraw-Hill), Oberg has long been fascinated by astronauts and others who test their limits under adverse conditions. As for the cave experience, Oberg comments, "I'd never do it unless they provided me with three kegs of wine, a hot tub, and my husband." And probably a toilet, which she discusses in "Cosmic Relief" (Space page 20).

Research editor *Justine Kaplan* is more interested in dolphins, which have fascinated her since she was in the seventh grade. Water-skiing off Florida's Gulf Coast, she lost her grip and fell into the water after she saw five dorsal fins moving with great speed toward her. "I was paralyzed by fear because I thought sharks were going to attack me," Kaplan recalls. When they began nudging her toward shore, however, she realized her rescuers were dolphins.

Years later Kaplan met Louis Herman when she applied to his graduate program in marine mammal psychology at the University of Hawaii. "He made me very aware of the laborious nature of research," Kaplan says. "Studying dolphins is much harder work than writing about them, and that's saying a lot."

Kaplan recently returned to Hawaii to meet with Herman and discuss his work for this month's Interview (page 76). And in the article "The Day of the Dolphins" (page 42) she reports on developments in dolphin research around the country. How intelligent are dolphins? Will we ever be able to fully communicate with them? If so, one benefit may be the ability to eventually communicate with extraterrestrial beings.

The world of dolphins teems with seemingly alien exotica. One of the most architecturally striking marine life forms is coral. And in "A World of Coral Harmonies" (page 58) the detailed photographs of coral polyps offer views that even most divers never see.

Water, of course, may be the source of an abundant, renewable, nonpolluting—in fact, perfect—fuel, if advocates of hydrogen energy have their way. In "Road to Power" (page 66) *Robert Keating* reports on the potential of hydrogen power as an alternative energy source. The plans to extract energy from this common element have been in the lab for years, but they've been hindered by the high costs of production. Now, however, environmental concerns are making hydrogen's future brighter.

We will eventually bequeath our planet to today's children, and their future depends in large part on the educational opportunities we offer students now. As *Karen Emmons* points out (Forum page 18), some schools have already recognized the need to bring the corporate community into the classroom. And businesses and organizations including *Omni*, are responding to tip the odds in favor of the future. OO

OMNI

BOB GUCCIONE
Founder & publisher

KATHY KEETON
president

OMNI PUBLICATIONS INTERNATIONAL LTD.

THE CORPORATION
Bob Guccione, *chairman of the board*
Kathy Keeton, *president*
David J. Myerson, *chief operating officer*
Anthony J. Guccione, *secretary-treasurer*

EDITORIAL
Executive Editor Bob Guccione, *Editor* Peggy Noonan, *Managing Editor* Steve Fox, *Senior Editors* Pamela Weintraub, Jane Bosveld, Marilyn Cox, *Fiction Editor* Ellen Datlow, *Humor Editor* Bill Lee, *Staff Writer* Kathleen Keating, *Associate Editors* Tom Dworetzky, Kevin Mahoney, *Copy Chief* Leslie M. Bydlon, *Copyrights Manager* Babette C. Lefrak, *Senior Editor* Ben Spier, *Pictorials Editor* Nina Roberts, *Research Editor* Justine Kaplan, *Assistant Editors* Mary S. Glucksman, *Editorial Assistants* Susan Rudavsky, *Games Editor* Scot Morris, *Editorial Director, Book Division* Babette C. Lefrak, *Assistant to Editorial Director* Robert Mangino, *Contributing Editors* Ellen Kunes, Jill Lawren, Marion Long, Cathy Spencer. Offices: 1965 Broadway, New York, NY 10023-5965, Tel. (212) 496-6100, Telex 237128.

ART
Sr. VP/Graphics Dir. Frank DeVito, *Art Dir.* Douglas Flinchum, *Assoc. Art Dir.* Cheyenne Lundberg, *Asst. Art Dir.* Pam Levy, *Art Assistant* Ed Bridegard Kren, *Asst. Photo Ed.* [illegible], *Art Rights Mgr.* Gwenn Lewis, *Administrative Assist. to Bob Guccione* Jane Kotula

ADVERTISING AND MARKETING
Pres., Marketing Div. William Mateo, *VP/Dir. of Adv.* Linda Nowman, *Sr. VP/Corp. Dir. New Bus. Develop.* Beverley Wardale, *VP/Dir. Group Adv. Sales* Nancy Kenterbaum, *Assoc. Dir. Adv.* Sharon Scott, *New England Mgr.* Jane Gooch, *Sr. VP/Midwest and Southern Adv. Dir.* Peter Goldsmith, *Midwest Mgr.* Philip A. Wert, *Western Adv. Dir.* Susan K. Sanford, *Assoc. Adv. Mgr. Southern Reg.* Jo Tarlton, *Marketing Production Dir.* Eileen Brandes Garber, *Adv. Prod. Dir.* Charlene Smith, *Adv. Prod. Traffic Mgr.* Mark Williams. **Offices:** *New York,* 1965 Broadway, New York, NY 10023-5965, Tel. (212) 496-6100, Telex No. 237128; *Midwest,* 333 N. Michigan Ave., Chicago, IL 60601, Tel. (312) 726-9393, Fax (312) 346-3516; *Detroit:* Wynn-Hannah-Albaum Inc., 2685 Lapeer Road, Suite 100, Auburn Hills, MI 48057, Tel. (313) 377-1026; *Northeast and Canada,* 1200 Post Road East, Westport, CT 06880, Tel. (203) 226-8976; *South,* 1707 H St. N.W., Washington, D.C. 20006, Tel. (202) 296-6050; *West Coast,* 6725 Ekon Ave., Canoga Park, CA 91303, Tel. (818) 992-4777; *U.K. & Europe* Penthouse Clubs Ltd., 21 Whitehorse St., London W1 England, Tel. [illegible]; Intergroup Communications, Ltd., Pres., Joe Sambo, 3F Tiger Bldg., 5-22 Shiba-koen, 3-Chome Minato-ku, Tokyo 105, Tel. 03-431-2607, Telex J25469 IGLTYO, Fax 434-5970; *Korea,* Kaye Advertising Inc., Pres., S.H. Hwang, Room 402 Kunshin Annex B/D 251-1, Dohwa Dong, Mapo-ku, Seoul 121, Tel. 719 6906, 6907, 6913, Telex K 32144 Kayaad, Cable: Kayaad, Seoul, Fax 822-7199816

ADMINISTRATION
C.O.O. David J. Myerson, *Sr. VP/Administrative Services* Jon Winston, *Sr. VP/Production Director* John Evans, *Sr. VP/Chief Financial Officer* John Probich, *Controller* Patrick Keane, *VP/Newsstand Circ.* Marcia Orevitz, *VP/New Magazine Development* Rose Cherry, *Dir. East Reg. Sales* Chuck Anderson, *Dir. West Reg. Ind. Sales* Bruce Eldridge, *Newsstand Dist. Mgr.* Lou Rossi, *VP/Dir. of Public Relations* Marcia Polash, *Publicist* Peter A. Prosen, *Dir. of Sales Promo./Marketing* Beverly Greenbet, *Research Dir.* Eli Bebi, *Prod. Mgr.* Jon Stinson, *Asst. Prod. Mgr.* Nancy Rose, *Dir. of Sub. Circ.* Marcia Schultz, *Traffic Mgr.* William Hebbutt

FOREIGN EDITIONS
Sr. VP/Foreign Editions John Evans, *For. Edit. Mgr.* Linda Quinn, *Japan,* Obunsha Company, Ltd., 55 Yokodera Cho Shinjuku-ku Tokyo 162 JUNE

LETTERS

COMMUNICATIONS

The Way We Were

It's not often I read articles that feel as though they have the power to change my life. James Gorman's interview with paleontologist Jack Horner [March 1989] had just such an effect on me. We get so self-involved that we forget the incredible world that lived and breathed and romped without our technological assistance. When Jack Horner was eight he found a dinosaur bone and has since formed a life that appreciates the world's earlier inhabitants. My appreciation is renewed, and life is once again in proper perspective.

D. L. Gassie
Richmond

Bite of the Iguana

Jeff Goldberg and his iguana appetizer [Omnibus, March 1989] brought to mind a popular Mark Twain quote: "If you have to swallow a frog, it's best not to look at it too long." Although Twain may not have meant this literally and probably did not have fine lizard cuisine in mind, I'm sure Goldberg can relate.

Patrick Tierney
Denver

Cold Feet

I have been reading *Omni* for six years now and have always enjoyed your insightful look at the future. After reading "Out in the Cold" [Continuum, March 1989] I thought I'd mention how my friends and I make use of the idea that freezing things makes them last longer. For a few years now, before wearing my panty hose, I wash them, place them in a sandwich bag, and freeze them overnight. Then I defrost them, let them dry, and wear them. I've found that my nylons survive longer this way.

Ruthann Allen
Fresno, CA

Ecumenical Counsel

The controversy over whether Srinivasa Ramanujan ["The Master of Math," March 1989] was religious betrays Western assumptions of what constitutes religion. To mathematician G. H. Hardy, Ramanujan "was no mystic" because he said that all religions "seemed to him more or less true." This might preclude religion according to Christianity or Islam, but not necessarily to Hinduism, whose definition of religion is broader and more flexible than ours. Indeed, Ramanujan was obviously more of a cultural Hindu than philosopher Jiddu Krishnamurti, but Krishnamurti was still declared a holy man by the most influential Hindu leaders. Their religiousness is ambiguous because Hinduism has always had room for ambiguity.

Miles Fowler
El Cerrito, CA

A Better Idea

We printed a cartoon without a caption? Yes, we did, on page 56 of the March 1989 issue. The *Omni* humor department was just "testing" the ability of our readership to find the minor discrepancy in the cartoon that shows two doctors confused at the sight of a patient sprouting leaves. The staff of the Smithsonian National Air and Space Museum graded well with a caption of their own: "I have no idea what it is, but it gives a whole new meaning to the term *personal growth.*" And so did Bil Plummer from Lafayette, California, with "It was a misunderstanding. He thought I said 'Take two *aspens* and call me in the morning.'"—*Bill Lee, humor editor*

There's No Place Like Home

I loved your travelogue ["*Omni*'s Five Star Travelogue," March 1989], especially your "ten best rides in America." You did my hometown of Brooklyn proud when you included the Cyclone roller coaster on your list, but I've got some bad news for you. The Cyclone's not the only or even the best game in town. For true stomach wrenching, knuckle-whitening thrills, I recommend to out-of-towners a ride through midtown Manhattan in a New York City taxicab during rush hour. I've taken both "rides," and the Cyclone is less frightening.

John Hitf
Brooklyn

HIRE EDUCATION

FORUM

By Karen Emmons

Some Freudian psychology says I'm supposed to stroke you and tell you you're doing well even when you're not,' hollers a teacher in a Harlem junior-high school. "But your background's not Europe. It's Africa. You're not doing well. And I'm telling you. You're not doing well." An awkward hush sweeps across the auditorium where the seventh- and eighth-graders at PS 175 are rehearsing their African–American Heritage pageant. Then a few nervous giggles break out. Pushing on, the teacher bellows, "This country doesn't need another black person who can't read or write. It can make a computer that doesn't require health benefits or a paid vacation."

These children are the college graduates of 1998 and 1999—if they stick with it. Of the 3.5 million eighteen-year-olds in the country last year, nearly one quarter were high-school dropouts and another 700,000 couldn't read their own diplomas. Local officials predict that half of the 100 eighth-graders at PS 175 will go on to college.

The Henry Highland Garnet School for Success, officially known as Public School 175 but named for a clergyman and antislavery crusader, has taken some innovative steps in hopes of surprising the odds makers. In the classroom, school administrators and teachers are recognizing the history and unique social problems of their students. And in the real world of financing educational opportunities, they have recognized the need to bring the corporate community into the classroom. Some 15 businesses, including *Omni*, that share a concern about what the future may have to offer these children have committed themselves this past year to "adopting a classroom." It's a goal Garnet principal Carol Foster says is critical. "America is saying that to get a good job, you need a college degree. I want every child I come in contact with to go to college," she says. "In ten or fifteen years these kids will be knocking on doors looking for jobs. Businesspeople should help them now to get proper qualifications."

Omni president Kathy Keeton spends time with her adopted class at New York PS 175.

Located in the middle of New York City's Harlem, PS 175 is grim and fortresslike, surrounded by abandoned and badly decaying buildings (a crack house operates across the street). Inside, the nearly 400 kids in grades kindergarten through eighth are as charming as they are unruly. Some are the children of drug addicts and alcoholics who abused or neglected them, says Foster. One minute they are hardworking and earnest, the next they are hollering and hopping around the room. Under the tutelage of Foster and her staff of 25 teachers, reading levels at PS 175 have improved on average from three years behind grade level in 1985 to grade level or above this year. They study German and read *Bury My Heart at Wounded Knee* (donated by *Omni*, along with other books). And most Fridays their sponsors spend the afternoon talking about career possibilities, helping students with homework, and taking them on field trips, often to the company offices. *Omni* has donated a Sony television, a GE VCR, and an Apple computer and printer, with which *Omni* editors and students in Grover McArthur's eighth-grade class are working on a class newsletter.

The adopt-a-class program was started in the New York City school system one year ago. PS 175 is the first school to have won sponsorship for every one of its 15 classrooms. Sponsors range from the United Auto Workers union, police officers, and AT&T to a local hardware store owner. The adopt-a-class program was designed not only to attract financial assistance but to bring in "people who are passionate about what they do and who can bring that out in the kids," says Foster.

But the program's benefits flow in more than one direction. "They have given me more than I have given them," *Omni* president Kathy Keeton announced at a Christmas party the magazine gave the students.

"I feel good when I help people. I guess she does, too," said Mohammad El-Amin, fourteen, of Keeton. Keeton

CONTINUED ON PAGE 64

COSMIC RELIEF

SPACE

By Alcestis Oberg

Thomas Crapper earned immortality by inventing the porcelain bathroom fixture that today bears his name. Someday the same fate may befall Henry Whitmore if his design for the commode aboard the space station *Freedom* turns out to handle the stuff right. "I didn't want to get involved at first," says Whitmore, who is one of the developers of the space program's exercise gear. "But I'll probably be remembered for the toilet."

Laugh, but if the "Whit" works, its inventor will have earned his place in history. Engineers have had more trouble coming up with a zero-g toilet than just about any other piece of aerospace equipment. It hasn't been for lack of trying—or funding. Space insiders put a million-dollar tag on the shuttle toilet and estimate that R and D for the next generation will run at least $3 million.

Before the shuttle era, the toilet was a plastic sack the astronaut held against his posterior. Fliers could guide their floating wastes to the bag's bottom by taking advantage of the bag's built-in finger pockets.

The palatial 100-ton *Skylab* featured a plastic-bag-lined toilet much more like the one at home—except it was on a wall. A hose served as a urinal.

The space shuttle was to herald a new high-tech era for off-world toiletry: coed, recognizable, even mounted on the floor, with a privacy curtain.

The original idea was that the astronauts would merely activate a "slinger"—a series of revolving tines at the bottom of the bowl. These would shred the material and smear it along the plastic-lined wall of the bowl, where it was to be instantly freeze-dried.

Regrettably, many problems ensued. Most of these involved components that clogged and malfunctioned. These troubles were more than inconvenient. They could create a brown dust inside the craft, a fecal grit that held the promise of eventually threatening electronics . . . and humans alike.

The slinger was removed and the matter allowed to just bob around, held within the bowl by the application of a modest, constant airflow. "It was a sodden, frozen mess," says one astronaut. At first, crew members got to use a spatulalike implement to clear room in the floating mass for their new contributions. Next, designers installed an arm with a net for use mid-mission to trap and hold the half-time accumulation out of the way. But it's not perfect. The astronauts must put all their used paper squares in a drawstring bag drifting beside the toilet. Also, the hole at the top of the can is only four inches across; shuttle riders must train before the flight to make sure their aim is true.

While astronauts regard toilets past and present as unpleasant and unsanitary, they can tolerate them for a week. But on a permanent space station with crews of eight in orbit for six months at a stretch, a toilet breakdown would be a full-blown disaster. "Proper sanitation is very important, especially in a closed environment [like the space station's]," says astronaut-physician William Thornton. Refuse won't be tossed overboard.

Orbital toiletry. A better head than the Reds?

on *Freedom* (as is now done aboard *Mir*). Inside its sealed system, everything that is "waste," including the output of the sanitation system, must be properly stored until it can be returned to Earth.

There are two leading contenders for the right to become *Freedom*'s head. Both use airflow to keep the matter in the can from drifting out and employ charcoal filters to control odor. They also rely on a trash-compactor approach to reduce the volume of solids.

Whitmore's is the simpler design—both to use and to maintain. Philosophically, it resembles a Volkswagen approach to the orbital latrine. The top closes, and a square piston slowly pushes the waste forward. In the process, the piston (which is lined with a specially treated plastic–paper) squeegees clean the walls of the bowl. The Whit can mash 60 "events" worth into a container smaller than a cubic foot. There are also features that allow the Whit to work even if components malfunction. The piston can be cranked by hand if the automated pushbutton system fails.

More upscale and more complicated is the design from Hamilton Standard. This company already has cleaned up in the space-waste business. It handles the shuttle toilet after each flight at a rumored cost of $50,000 per round trip. Hamilton Standard's plans call for a cylinder-shaped bowl lined with a bag made of plastic that lets air—but not fluid—pass through. For "flushing," the bowl rotates, its lid shuts, and the whole assembly moves backward until it winds up under a piston. The piston then comes down and compresses the waste and the bag into a 50-visit can.

The two designs are not far apart actually, and a compromise may be in the offing. Whitmore has recently become a Hamilton Standard subcontractor, so it's possible that the head that finally winds up on *Freedom* will contain the best of both designs. "Whatever we use," promises Rafael Garcia of NASA's Manned Space Division, "it will be tested, retested, and tested again until *everything* is correct."

THE TEN-MINUTE PAIN TRANSPLANT

mind

By Douglas Stein

Just months ago surgeons at Yale Medical School grafted fetal nerve cells from an elective first-trimester abortion into the brain of a forty-eight-year-old woman. For 21 years she had suffered from Parkinson's disease, whose symptoms include severe tremors, muscular rigidity, and difficulty of movement. The long-term effectiveness of this revolutionary brain-grafting operation will take months to evaluate. But scientists in the United States, Europe, China, Cuba, and Mexico are becoming increasingly convinced that tiny brain implants of human fetal and other neural tissue will prove to be the most powerful new weapon in combating nervous system diseases such as Parkinson's.

Besides potential medical applications of immense consequence, the neural graft provides a unique tool for basic research. It enables scientists to peer into the depths of the brain itself. For one researcher at least, these studies are turning up surprise after surprise about how grafted cells react—as well as several unexpected potential applications for the treatment of pain, depression, drug addiction, and more.

For nearly four decades George Pappas, head of anatomy at the University of Illinois, Chicago, has studied synapses, the minuscule junctions between nerve cells. Pappas recalls how Jacqueline Sagen, a young neuropharmacologist with an interest in pain pathways, came to his lab to learn techniques of electron microscopy. "It was she, after all," Pappas says, "who introduced me to pain. I myself had never been interested in it. But at the time Mark Perlow, the surgeon who pioneered some of the experimental adrenal transplants in rats, happened to be here. So we put our heads together."

The adrenal glands are a pair of complex endocrine organs that sit on top of the kidneys. Each gland has two parts—a cortex, or outer bark, and a core, called the medulla, that contains chromaffin cells. Functioning like tiny chemical factories, these very large cells manufacture, store, and secrete into the bloodstream a plethora of hormonal products, including adrenaline. All these substances except adrenaline are produced in small quantities.

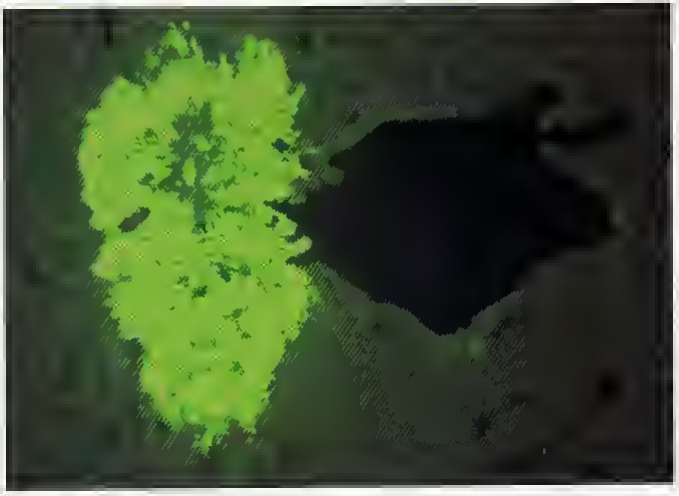
"I wanted to see how these chromaffin cells might release their various contents after being transplanted into a foreign environment," Pappas recalls. "Because our focus was pain, Sagen and I thought, *Why not put these big cells into areas of the brain where there are lots of opiate receptors and see what happens?*" The brain contains natural morphinelike chemicals that fit, lock-and-key style, into neurons in specific brain areas.

Pappas and Sagen harvested their chromaffin cells from cows and rats. They grafted them into two regions of the rats' nervous system: the lumbar, or lower spinal cord, and the periaqueductal gray matter (PAG) of the brain. The PAG, located near the top of the midbrain in humans, funnels impulses from higher brain regions back down into the spinal cord. The PAG is the center of the brain's own pain-suppression system. An injection of morphine into the PAG produces the most potent painkilling effect of any brain region.

Pappas and Sagen evaluated their first series of brain-grafted rats with the same tests drug companies have used for 50 years to screen potential pain medication. They saw that the animals with intact transplants had dramatic reductions in their awareness of acute pain. The spinal grafts produced even greater pain reduction.

Once the chromaffin cells were taken out of their natural environment in the adrenals, Pappas found, their chemical production changed. Rather than adrenaline, the neurotransmitter norepinephrine became the predominant product. Equally important, the cells' production of Met-enkephalin, a natural opiate, shot up more than 20 times. "This is very, very good," explains Pappas, "because the combination of the two is synergistic. It creates a powerful analgesic cocktail."

These implants effectively blocked



Adrenal tissue (glowing circle), put near the brain's aqueduct, churns out potent painkillers.

ENGLAND

KNOWN FOR ITS PLAYBOYS.

AND ITS GIN.

THE GIN OF ENGLAND. AND THE WORLD.

GORDON'S®

PRODUCED IN U.S.A. ACCORDING TO THE FORMULA OF ALEXANDER GORDON AND COMPANY LONDON ENGLAND
100% NEUTRAL SPIRITS DISTILLED FROM GRAIN. 40% ALC/VOL (80 PROOF). THE DISTILLERS COMPANY, PLAINFIELD, ILL. AND UNION CITY, CA. © 1985

short bursts of acute pain, but would the transplanted chromaffin cells kill chronic pain? To find out, Pappas and Sagen injected rats with a bacterial preparation causing severe joint inflammation. Within weeks the rats suffered a crippling arthritis. "These rats are squealing, making sounds rats don't normally make," Pappas says. "We know they are definitely in pain."

Yet after receiving the chromaffin implants, this group of arthritic rats began to eat again, gain weight, and move freely around their cages. Their squeal levels came down an enormous amount. And," marvels Pappas, "they behaved as if they were not feeling any pain. But I want to stress that we haven't affected the condition itself in the slightest—their hind paw joints remained just as swollen. We've affected only their pain perception."

Tracking these rats for a year—half a rat's lifetime—Pappas and Sagen found that the transplanted chromaffin cells continued to pump out elevated levels of both painkilling Met-enkephalin and norepinephrine. The chemical cocktail sustained its powerful pain-suppressing effect for the duration of the rats' lives. And perhaps more important, there was no increased tolerance. In almost all pain medication, tolerance is the unwanted shadow. It takes more and more of the drug to do the same job. For patients with advanced cancer, doctors often prescribe Tylenol along with morphine to slow the buildup of tolerance. When Ronald Reagan had colon surgery, for example, Tylenol along with morphine was continuously pumped straight into his colon through a cannula, or small tube.

These chromaffin cell grafts in rats were so successful at augmenting the animals' own pain-suppressing system that Pappas and Sagen were certain that the medical community would be interested in it. And they didn't have to wait long. Says Pappas, "Dr. Tapas DasGupta, a well-known surgical oncologist, has already initiated the spinal transplants of adrenal medullary tissue in cancer patients right here in Chicago." But relief from cancer and arthritis pain are only two of many possible applications for these grafts.

"Man is a social creature," Pappas philosophizes, "so there's this overwhelming need to treat chronic pain. To speculate a bit, I can see the day when people will go to a doctor's office and have some chromaffin cells—bovine, porcine, whatever—carefully grafted into the lumbar region of the spine. Maybe a few years later they'll go back and have a few more cells put in. We've got to work out a means of anchoring the tissue to the wall of the spinal canal and making sure there are no immune-rejection problems. But I'd say that within five years there will be a grafting procedure to alleviate chronic, intractable pain that might take ten minutes in a doctor's office. This is a marvelous thing!"

Although the focus of Pappas's work was the study of pain, he discovered a few totally unexpected things while examining electron micrographs of tissue areas surrounding the PAG implants. First, although Pappas used no cyclosporine, an immunosuppressant drug, the rat brains did not reject the cow chromaffin cells. "Immunologist colleagues are very surprised when I show them micrographs of tissue that has not been rejected," says Pappas. "We saw lots of phagocytes [immune-response cells] just hanging around. They reminded me of soldiers who normally fight. But here, instead of fighting, they're standing around doing nothing." A new mystery for neuroimmunologists to ponder.

Second, Pappas saw that neurons normally lacking a myelin sheath had become myelinated. Myelin is a fatty insulating material wrapped around the axons of many neurons that is essential for the speed and fidelity of the nerve impulse. The chromaffin implants had somehow induced what's called an "oligodendrocyte response." That is, cells that produce myelin had "turned on" in areas of the brain where they are usually "silent." "People investigating demyelinating diseases, such as multiple sclerosis," continues Pappas, "are very interested in this unexpected myelination. It's an interesting sidelight that we plan to pursue."

> *"I can see the day when people with chronic pain will go to a doctor's office to have chromaffin cells—bovine, porcine, whatever—grafted into the lumbar region of the spine."*

And Pappas sees brain implants as a likely treatment for depression and drug addiction. Because scientists think many drug addicts are chronically deficient in natural opiates, the PAG graft could supply the missing amounts. And if that works, grafts of other natural "psychoactive chemical" factories might be used to treat depression and mental illness. "People generally go to a doctor for two reasons," says Pappas. "They've got lots of pain or they're depressed. And of the many theories about depression, the most prevalent is that depressed people lack one or more brain chemicals, specifically serotonin and norepinephrine."

The lab animal model for human depression is called learned helplessness. "You essentially teach a rat that he cannot learn anything," explains Pappas. "After teaching him something, you punish instead of rewarding him. After doing this in many different contexts these rats are in such a bad state they just sit catatonically, refusing to move to a different area even when shocked. 'You've done such a job on them,' says Pappas with obvious distaste, 'that they're not interested in anything.'"

Rats in this condition suffer a chronic decrease of serotonin and norepinephrine in various brain areas. In an attempt to reverse this induced depression, Pappas and his colleagues performed three kinds of transplants on the rats. In one group they took cells harvested from the pineal glands of healthy rats. The pineal gland responds chemically to changes in light, among other things, and throws off an enormous amount of serotonin and melatonin. He grafted these cells into the frontal region of the "learned helplessness" rats' brains. A second group of rats received chromaffin cell implants in the same area. The last group had both cell types grafted into their brains. "All three grafts had some effect. But for the rats with the pineal–chromaffin cell combination, no matter what we did, we could not reinduce a state of learned helplessness," crows Pappas.

"The important thing about our work," he continues, "is that the brain structure of these animals is essentially healthy. It's not a situation like parkinsonism or, worse still, Alzheimer's, where you have localized or wholesale brain degeneration. Our rats, whether pained or 'depressed,' suffer only a chemical deficiency. And we can compensate for that deficiency very effectively by adding cells that make that chemical, whether it's enkephalin, norepinephrine, serotonin, or possibly others."

Sophisticated imaging systems, such as magnetic nuclear resonance or positron emission tomography (PET), as well as autopsies have yet to detect brain degeneration in depression. Where there is no brain degeneration, transplants of norepinephrine- and serotonin-secreting cells into the limbic areas—the so-called seat of the emotions—hold promise of being effective therapies for long-term depression in humans. Grafts could replace today's antidepressant drugs, with all their far-reaching side effects. That such tiny implants might one day provide permanent mood elevation for millions of chronically depressed people is, in Pappas's words, "not too much to hope for."

SAVE OUR SEA MAMMALS

EARTH

By Kenneth Brower

William Randolph Hearst, massive in the chest and shoulders, his rheumy eyes half closed, gazed straight up into the foggy sky. Two doors away Theda Bara's daughter Tuesday lay naked on the white concrete beside her pool.

The sun broke through the fog. For the first time that day William Randolph Hearst began to heat up. A girl in hip waders unreeled a black hose and turned it on Hearst. He barked at the sky but seemed to enjoy it.

W. R. Hearst, the Citizen Kane of the California Marine Mammal Center (CMMC), is a bull California sea lion. He stranded, weak and suffering seizures, near San Simeon, site of the old newspaper baron's palace, and thus the name. Now recuperating at the rehabilitation center, on the Marin Headlands north of San Francisco, Hearst is almost himself again and soon will be back in his element. Dozing with eyes nearly closed—his favorite way of passing the day—he may imagine he is home already. The center is as noisy with barks, bleats, roars, and coughs as any seal rock offshore. Last October, when I visited, 40 sick or injured pinnipeds occupied the cages around the bull. Among them were Arizona, a 292-pound juvenile male sea lion discovered by a woman from Arizona, Padre, a younger male discovered by a priest who called the rescue line at the center, blessed the lion, then waited with it for help to arrive, and Aimee, a female with a horrible cough and an IV of lactated Ringer's injection dripping slowly into her veins.

The pinnipeds I had come to see, however, were a particular group of sea lions from the vicinity of San Luis Obispo. The group was an epidemiological mystery. The first, Theda Bara, had arrived April 30, 1988. She had demonstrated all the symptoms that the later arrivals would demonstrate: grand mal seizures, lethargy, and biting episodes so frenzied and violent that teeth were broken off against the cages. Theda Bara was on the verge of death when workers noticed independent movements in her stomach. On a Tuesday she underwent a Cesarean, was delivered of a pup named for that day—the first sea lion ever delivered by C-section—then she died as the vet stitched her up.

To date, from a sharply delimited stretch of the central California coast, 26 sea lions have come in with the seizure disorder. Among them have been William Randolph Hearst, who it appears will survive, and Aimee, who it appears will not. It is interesting that once removed from the waters of San Luis Obispo, 75 percent make total recoveries. The center's consulting scientists suspect heavy-metal poisoning. Tests have revealed what seem to be high levels of lead and other heavy metals in their bodies. No baseline studies for heavy metals in sea lions exist, however, and no one knows for sure what levels are normal. It is impossible as yet to rule out a biotoxin, but the scientists lean toward some toxin of the artificial kind. A shipload of copper is said to have gone down in the vicinity. Could the poison be copper? Oil exploration is under way offshore. Could the poison be some toxic property of drilling mud? The Diablo Canyon nuclear power plant discharges its cooling water just west of San Luis Obispo. Could radiation be to blame? The possibilities are endless. The United States dumps more than a ton of hazardous waste per citizen per year. American industry invents and manufactures thousands of new compounds annually. The effects of few of them are tested on the terrestrial ecosystem, let alone the marine. Sooner or later the new chemicals, along with the old—crankcase oil, fertilizers, pesticides, sewage—find their way down to the sea.

The smallest of marine mammals, the sea otter, was hunted to the verge of extinction by the end of the Russian era in North America. The largest of sea mammals, the blue whale—the largest species to have lived on Earth—had become one of the most endangered by the 1930's. The largest of pinnipeds

CONTINUED ON PAGE 64

Will they reestablish themselves, or are they caught between a rock and a hard place?

ARTIFICIAL INTELLIGENCE

By Bill Lawren

We're in the year 2040, and it's just another Monday at Design Innovations, Ltd., a firm that creates everything from left-handed monkey wrenches to self-cleaning frying pans. Today's assignment: An extermination company wants to build a better mousetrap. But the men and women of Design Innovations don't just sit at their desks, waiting for the creative muse to inspire them. Instead, they punch the exterminator's order—along with some relevant numbers—into their computer. A few minutes later it spits out a design, an ingenious blueprint for a new and better trap.

The computer of the future will do more than just call up information and solve logical problems. According to computer scientist Brian Williams, it will possess the ability to invent.

In order to give computers the powers of ingenuity, imagination, and intuition, Williams has broken down the mental components of the inventor's musings and expressed them in a new form of mathematics. This new math, Williams theorizes, may give the computer something it has always lacked: a creative, humanlike imagination.

Williams, a Ph.D. candidate at MIT's Artificial Intelligence Lab, first envisioned the possibilities of computer creativity while holding down a summer job designing computer chips. Could there be a way, he wondered, to program a computer to "invent" new varieties of chips on its own, without relying on a human designer? Some special computer-made design programs existed, but the machines couldn't come up with really innovative designs.

A computer language for employing what philosophers and artificial intelligence specialists call qualitative reasoning was lacking. "Qualitative reasoning," explains Williams, "is the average human being's *intuition* of the physical world." Even someone who has never had a physics course, for example, instinctively understands that when he turns on a faucet, water comes out. One step up from your average person is your average inventor, who understands, almost instinctively, how the parts of a system—such as the gears in a car transmission—interact to make that system work. When he wants to design something new—like a solar-powered engine—he adds an element of ingenuity, perhaps moving the existing components around or introducing different parts.

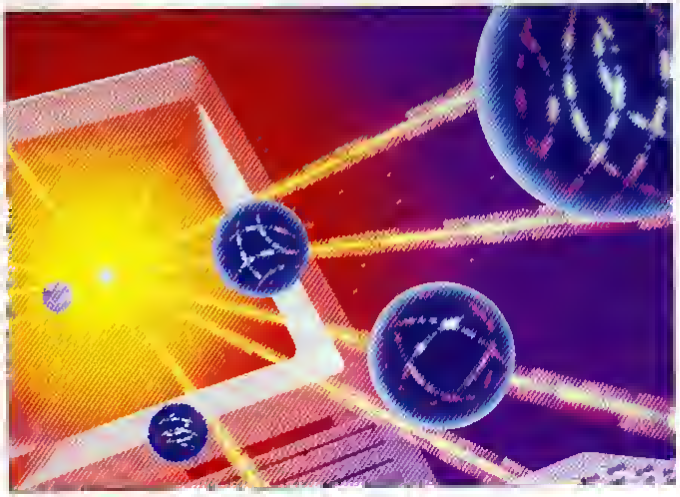
Williams is developing a series of mathematical equations to mimic the human reasoning process. It's a kind of "qualitative algebra," which will be used by the computer brain to devise programs that will guide it through the process of invention.

Previous attempts to come up with this new algebraic language have all failed, primarily because they were not flexible enough to deal with complex, *real* problems. But Williams is combining his new qualitative algebra with the traditional, "quantitative" kind taught in high school. The result: His new "hybrid" math possesses the flexibility that earlier versions lacked.

Williams's new algebra, which he calls Q1, is a mathematical replica of the thought processes inventors and designers employ to creatively solve a real problem. Each part of the thought process is broken down into a separate equation. To begin with, the designer's ultimate goal is formulated into an equation. He or she then feeds the "goal" equation into the computer with a slew of other algebraic equations. These represent such variables as the physical characteristics or properties of the components involved, the way they behave, and, finally, potential modifications of these different parts. The computer can then put together all of these different equations, and as it does, numerical "suggestions" and substitutions will pop up that can lead the computer to arrive at a fresh solution.

Williams has tested his Q1 system by feeding a computer the algebraic equivalent of the ancient design for

CONTINUED ON PAGE 74



Wise drives: Computers equipped to muse and consider could be the next inventors

ENCYCLOPEDIA PSYCHEDELIA

BOOKS

By A.J.S. Rayl

During the spring of 1943, research chemist Albert Hofmann (Interview, July 1981) retrieved a formula that officials at the Swiss pharmaceutical firm Sandoz Ltd. had shelved five years earlier, shortly after Hofmann had first developed it. Once removed from the lab's research program, a substance was never tested again, especially when the initial investigations proved, as in this case, unimpressive. Hofmann, however, was looking for a lifesaving medicine to stimulate circulation and respiration. And he was nagged by a feeling that his shelved substance (synthesized from ergot, a parasitic grain fungus) possessed beneficial properties not identified in the earlier studies.

On April 19, 1943, Hofmann ingested a minute amount of the compound known as lysergic acid diethylamide-25. The result: He tripped into the pages of history as the first modern-day hallucinogenic astronaut, launched into inner space on an unplanned exploration of human consciousness.

Today, Hofmann's "problem child," as he later called it, is better known as LSD-25 or simply LSD. And for years it has seemed that its potential medical use might be lost forever. Then last summer, 50 years after Hofmann first synthesized LSD, a group composed mostly of LSD pioneers established the Albert Hofmann Foundation.

The primary goal of the nonprofit foundation is to create a library and world information center to be located in Los Angeles and devoted to the study of human consciousness. The center will house books, research reports, correspondence, tape recordings, and news clippings on the experimental trials and tribulations of LSD and other hallucinogens. It will also include information on other means of achieving altered states, research from such fields as psychiatry, psychopharmacology, ethnobotany, anthropology, and theology.

"Many people aren't aware of the research done before LSD hit the streets in the Sixties," says Robert Zanger, president and chairman of the foundation's board of directors. "But there is a tremendous body of literature, and we want to make it available to anyone who is interested."

Following Hofmann's 1943 LSD experience, researchers garnered intriguing, though inconclusive, results with LSD as a psychotherapeutic aid in the treatment of alcoholism, chronic depression, and psychosomatic conditions, for example. More than 2,000 articles and papers on LSD research were published in professional journals around the world.

The research records available to the public at the Hofmann Foundation will include, for example, psychiatrist Oscar Janiger's collection of LSD-influenced art (Forum, November 1987). During the late Fifties and early Sixties, Janiger extensively researched the effects of LSD on creativity, dispensing the hallucinogen to some 900 volunteers, average people as well as such notable participants as Anaïs Nin, Andre Previn, Jack Nicholson, and Cary Grant.

Hofmann, Librarian in the sky with diamonds

When word about LSD hit the streets, however, everyone from students to scientists turned on, tuned in, and dropped out in the largest uncontrolled mass experiment in history. LSD quickly gained a negative reputation. The Food and Drug Administration (FDA) moved in, confiscating LSD and halting even legitimate research in the United States. Janiger, for one, was forced to abandon his painstakingly documented research. Most other countries soon followed the U.S. lead.

Since the late Seventies, many researchers have attempted to study LSD's history and legacy, according to Janiger. Scattered around the world, however, many of the legitimate research studies and reports have been generally inaccessible. But in 1987 Janiger wrote to all the "original founding fathers of the movement" and enlisted their assistance in forming an organization that would offer a neutral forum for the study of human consciousness.

The foundation's board of advisers now reads like a Who's Who of consciousness research. It includes poet Allen Ginsberg, who took his first LSD trip in 1959—during government-sponsored experiments at Stanford University; neuroscientist John Lilly, noted for his studies of LSD in sensory-deprivation tanks; Andrew Weil, author of *From Chocolate to Morphine* and *The Natural Mind*; and Ram Dass, formerly known as Richard Alpert, who along with Timothy Leary was fired from Harvard for their controversial LSD experiments in the early Sixties. Such names, the founders hope, will legitimize a venture that opponents might construe as "a bunch of people who can look into an artichoke and see God," Janiger says.

"Not a single person believes that LSD represents a folly of our youth," Janiger says. "In fact, we believe it is worth reexamining. And it may be possible to do so now that we are far enough away from the prejudice and hysteria of the Sixties."

Such reaction to LSD in the Sixties is

CONTINUED ON PAGE 96

CONTINUUM

SEAGATE

I remember walking New Jersey s white sand beaches as a boy While standing too near the edge of a jetty I marveled at the force of the sea as waves hit the rocks a little differently each time then slipped back into their great source The sea seemed threatening When I stood in its waves it shoved and pulled me, occasionally knocking me to its floor and filling my mouth with sand And there were dangers jellyfish sharks, crabs broken shells Today however the sea is more threatened than threatening Last July raw sewage caused New Jersey beach closings from Asbury Park to Avon-by-the-Sea. This summer federal and New York State officials, armed with the knowledge of ocean tides and currents, will use helicopters and boats in an attempt to clean up floating garbage before it appears on beaches

Given the scope of the seas' problems and the media attention our waste-infested beaches have received I expected to see or hear something about this issue while on a press trip to Sea World of Florida Located in Orlando—home of the theme park—Sea World s entertainment includes the Penguin Encounter, dancing dolphins and people riding killer whales It struck me how clean everything was artificially so which prompted me to ask where the medical waste exhibit was The concessionaire didn t laugh The Florida park boasts seven major shows and 23 educational exhibits yet one could spend days here and never suspect that the world s oceans are in serious trouble

The press trip had been arranged to publicize Sea World's third successful killer whale birth in the care of man'—animal parkspeak for captivity Animal rights groups have long debated whether man has the right to keep wild animals in captivity This discussion though is becoming irrelevant as the seas become less able to sustain life In the future these animals may exist only in artificial environments

Sea World makes a point of its commitment to the conservation of marine life Park officials cite long-standing rescue and rehabilitation programs for sick and stranded animals at two of their parks and a major research facility in San Diego In Florida the park has helped lead the fight to save the manatee an endangered marine mammal indigenous to the state s coastal waters In addition through its educational programs Sea World has instructed more than 1 million students nationwide Also to its credit Sea World s Orlando park recycled 168 tons of cardboard last year and it recycles paint solvents and aluminum cans and forwards the proceeds to the Save the Manatee Fund

But for all its good works Sea World doesn t inform the average park visitor about the havoc man is wreaking on the world's oceans Last year Sea World racked up record profits and attracted about 12 million visitors to its four parks nationwide While Sea World thrives the world s seas are dying

Absent a major change in thinking localized coastal problems will become widespread and amount to ecological disaster Coastal areas are a major litmus test for the health of the planet says Oceanic Society executive director Clifton Curtis A change in public thought is necessary says Curtis before people will start to protect the planet

Sea World could be a part of this change There is a long history at Sea World of combining education with entertainment Everyone who buys a ticket to one of its parks should receive information on what he or she can do to protect—or in many cases heal—the sea Seminars could be tied in with an exhibit on the seas' future if protective measures aren't taken A film showing two versions of the oceans future could be featured one showing the horrors of continuing our current disregard for the health of aquatic life the other offering a vision of the hope that might accompany reform

Our seas need protection In March an Exxon tanker spilled 240,000 barrels of oil into the waters of Prince William Sound off the coast of Valdez Alaska Human error was implicated, the blood alcohol level of the ship s captain having been above the legal limit We were outraged It was a dramatic example of environmental destruction Yet much more insidious is the destruction all of us engage in every day by producing too much garbage—by thinking more of convenience than of conservation Unless some fundamental change is made in our assumption that waste can simply be flushed out to sea and forgotten future generations will travel to places like Sea World not for a glimpse of the dynamics of the undersea world but for a history lesson in what the life of the ocean once was —*DOOLEY ADCROFT*

CONTINUUM

Sensory perception: To date, weather predictions have had as much validity as psychic predictions. But a NASA lightning sensor, scheduled for a mid-Nineties launch, may change this.

LIGHTNING RODS IN SPACE

More than 200 years after Benjamin Franklin's famous experiments, scientists still don't understand precisely what causes lightning, how it moves through the atmosphere, or where it will end up. That may change, however, when NASA launches its Lightning Mapper Sensor in the mid-Nineties. The device, which will be part of an environmental satellite, will provide information on lightning flashes and chart lightning activity over much of the Western Hemisphere. These measurements will help scientists study the behavior of lightning and offer pilots, utility companies, and weather reporters more accurate information.

Because the strength of a thunderstorm is proportional to the intensity of the electrical discharge, the sensor will also provide valuable information about worldwide precipitation patterns, particularly over data-sparse regions such as the tropics and oceans within the sensor's field of view. This will aid efforts to develop global climatic models.

The Lightning Mapper Sensor is initially intended to be a research tool. If the prototype proves useful for forecasting, says Hugh Christian, an atmospheric physicist at the Marshall Space Flight Center, similar devices will be placed on all our weather satellites. "Someday, hopefully, you'll be seeing this on your TV news."—Steve Nadis

"This is the first age that's paid much attention to the future, which is a little ironic since we may not have one."
—Arthur C. Clarke

ADOPT A SCIENTIST

A few years ago, zoos and save-the-animals foundations hit on a new gimmick for raising money. They offered the public a chance to adopt—for a price—one of their animals. Noting the huge success of these programs, the National Alliance for Research on Schizophrenia and Depression (NARSD) in Chicago decided to do something similar. But instead of offering whales or wallabies, NARSD put up for adoption the only animals it has: its own scientists.

NARSD put out a press release describing ten young scientists, giving photos and descriptions of their research. For an "adoption fee" from $25 to $1,000, interested "parents" would get a photo of the scientist of their choice as well as ongoing reports on the researcher's work.

So far the fund has taken in only $5,000, far less than the animal programs.
—Bill Lawren

What do Cabbage Patch dolls have that scientists don't?

Remote controlled aircraft are making a big splash they're missing their carriers and landing in the sea

PARACHUTES FOR PLANES

Many futurists predict that drone aircraft (remote-controlled planes) will be an integral part of naval operations by the twenty-first century Already drones carry sensitive cameras that allow a ship s captain to see over the horizon they can also be fitted with electronic devices that intercept and jam enemy communications But there is one problem with the planes Although they can be easily launched from small ships using a catapult, they require a vessel the size of an aircraft carrier for landing That's because drones are not easily controlled during landing They may veer wildly off course On land this is rarely a problem, but at sea more than one drone has missed the ship altogether, winding up in the water

James Reufer and Alan Greenstadt of Pioneer Systems Inc , may have solved that problem with an invention called the Shipboard Air Vehicle Retrieval (SAVER), a low-tech device designed to catch drones in midair SAVER is composed of a parachute wing and a large, cup-shaped parachute both of which are tethered to the ship s deck. "As the ship moves forward passing air is trapped, which lifts the wing parachute two hundred feet up in the air and inflates the capture parachute so it can receive the approaching craft," Reuter explains

The drone is guided by a homing device directly into the back end of the inflated capture parachute The chute brakes the plane's momentum and collapses, wrapping itself around the aircraft ' It s like a big purse with a drawstring, explains Greenstadt Once the drone is captured the parachute wing keeps it aloft until the entire device is hauled down by a winch Says Greenstadt, ' Our invention will allow drones to be recovered by patrol craft and other small vessels including submarines "

Although SAVER is still a prototype and the inventors have no idea how much it will eventually cost, several nations have expressed interest in the system As Reuter puts it, It s not hard to understand why someone with a million dollars worth of equipment flying around would want to be able to bring it down and use it again "—Edward Duensing

"It's what we learn after we think we know it all that counts "

—Kin Hubbard

THE INCREDIBLE SHRINKING TURTLE

Science-fiction fringies and others have long dreamed of freezing the bodies of humans who are near death and reviving them at a later time when whatever's ailing them can be cured To date, that dream has been forestalled by a simple fact of nature When water freezes (human bodies are mostly water, remember?) it expands doing irreparable damage to the body's cells Well, biologist Kenneth B Storey of Carleton University in Ottawa reports that there's at least one reptile—the painted turtle—that routinely freezes in winter, then manages to thaw itself out undamaged in the spring

How do the turtles avoid deadly ice damage to the cells? According to Storey, certain proteins (as yet unidentified) in the fluid outside the turtles blood cells cause the fluid to freeze at a temperature slightly below freezing As the extracellular fluid turns to ice it draws most of the water out of the cells—there s nothing left to freeze and expand The cells stay in their dehydrated form— shrunken, wizened little prunes, Storey calls them—throughout the winter When spring temperatures thaw the icy fluid, the cells absorb the newly liberated water and are revived

It's a nifty biological trick that Storey believes may someday make it possible to freeze human organs headed for transplant operations not for just a few hours but for weeks or even months at a time As for freezing a whole human body forget it Storey says You just can't take a giant piece of meat like a human body" he says "freeze it and then hope to revive it later We're just too big with too many different types of cells —Bill Lawren

'If you keep your mind sufficiently open people will throw a lot of rubbish into it '

—William A Orton

Dehydrated turtles are yielding more than tasty soups

CONTINUUM

UNMANNED SHUTTLE

Now that the shuttle is flying again, NASA is considering developing an unmanned shuttle. This vessel, known as Shuttle C, will use existing shuttle components: an external fuel tank, solid rocket boosters, space shuttle main engines. Instead of an orbiter, Shuttle C will have a cargo pod strapped to the external tank and won't be equipped to return to Earth. To save money, NASA will outfit Shuttle C with used engines from the regular shuttle.

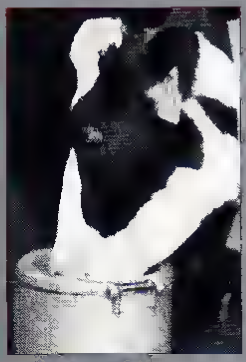
Shuttle C offers advantages over today's shuttle. Because it's not burdened with wings and a crew, it can launch up to three times the payload at one third the cost, says Robert Lessels, a NASA spokesperson. If the program is funded, Shuttle C could launch in late 1993.

The new shuttle, which NASA boasts is competitive with the Soviet Union's Energia, could launch as many as three times a year, ferrying deep-space probes and parts for the space station into low Earth orbit. —Devera Pine

BELCHLESS COWS

Your average cow serenely belches up to 400 liters (about 106 gallons) of methane gas a day, an awesome figure when you consider that all of the world's cows produce roughly 210 billion liters of the gas daily.

Add this to the methane produced by other beasts such as buffalo, sheep, and horses, combine it with the carbon dioxide spewed into the atmosphere from fossil fuel burning plants, and you have an exacerbated greenhouse effect.

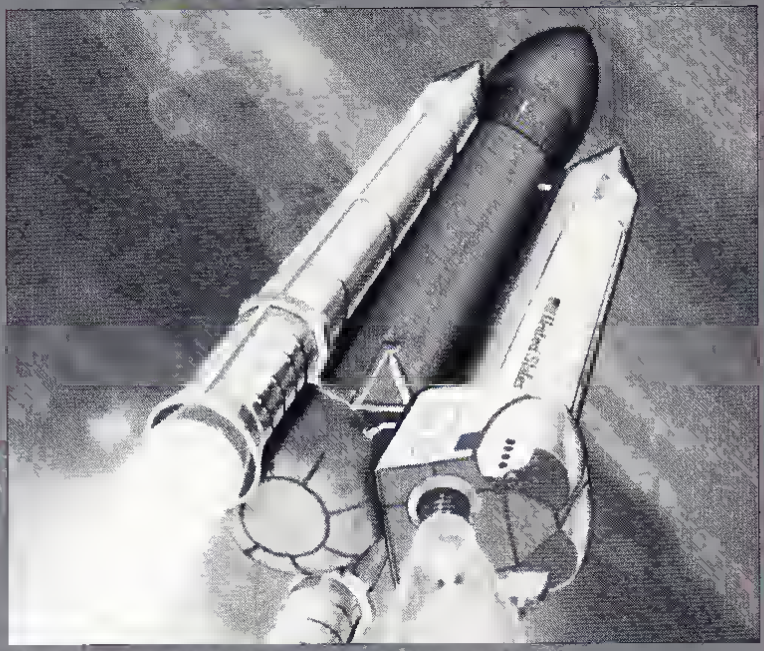


Are cow farts causing an environmental hiccup?

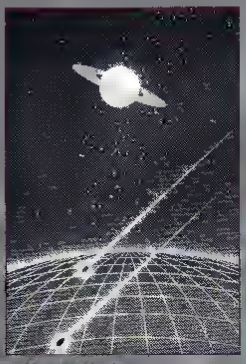
Donald E. Johnson, an animal nutritionist at Colorado State University in Fort Collins, may have discovered a way of decreasing the amount of methane cows give off. Much of the methane produced by cows is created when symbiotic bacteria in the rumen (the first section of the cow's stomach) break down cellulose into digestible cud. The by-product of this chemical decomposition is methane. Johnson suggests adding "weak selective antibiotics" called ionophores to the diets of cattle to inhibit methane-producing bacteria in the rumen, leaving room for other bacteria to flourish that can make a cow's digestion more efficient.

I am interested in finding and testing other compounds that could inhibit methane production and enhance animal digestion," Johnson says. Applied on a global scale, Johnson believes this might decrease atmospheric levels of methane.

—George Nobbe



According to the strategists at NASA, what goes up doesn't necessarily have to come down. In the future, a one-way ticket will hurl cargo into space.



Perplexing particles Strange beams are bombarding Earth

MYSTERY BEAM

Scientists at the Los Alamos National Laboratory in New Mexico along with researchers in Hawaii Arizona and West Germany have made a startling observation that sounds like a plot from *Star Trek* A mysterious beam of energy that appears to violate current theories about energy and matter is striking Earth

Physicist Darragh Nagle of Los Alamos explains that the bursts of high energy are coming from a neutron star Hercules X 1 located about 15 000 light-years away "Hercules X 1 is a member of a binary or double-star system Typically, ultrahigh energy emitters and the radiation they produce take the form of gamma rays [extremely high energy light waves] says Nagle "So when the pulse signals from Hercules X-1 were first picked up we assumed that was what we were dealing with Instead, we found that the beam has properties that don't fit in with gamma rays In fact, these properties are difficult to accommodate within our present knowledge of particle physics '

For example, after measuring the subatomic particles that fell to Earth when the beam collided with atoms in the atmosphere the researchers found an unexpectedly high number of short-lived, negatively charged particles called muons These particles are supposed to be present when bits of matter hit the atmosphere, but not when light waves do

Trying to explain the beam has proved baffling Nagle points out that in order to have traveled so far across space the newly discovered beam—which packs a million billion electron volts of energy, or about 1 000 times more energy than any accelerator on Earth can produce—must contain particles that are neutral light and stable and must react strongly when they hit atoms in our atmosphere

Protons almost fit that description 'They *are* positively charged and would have been scrambled by galactic magnetic fields, notes Nagle but "the signal we picked up was too well-defined to have been produced by protons ' Neutrinos although light, stable, and neutral, also can't explain the beam's properties 'Neutrinos as we know them don't interact strongly enough, he points out

One theory Nagle says, involves gamma rays which at extremely high energy levels may react far more strongly than anyone now suspects and behave almost more like matter than light when they hit the atmosphere

Nagle admits another startling possibility The mysterious radiation may contain particles that are new to science 'We delayed publishing our research for a year so we could recheck our calculations he says be cause frankly this phenomenon seems so bizarre

—Sherry Baker

"Consistency is the last refuge of the unimaginative' —Oscar Wilde

MINILIFESAVER

Wind surfers snorkelers scuba divers and other water-sport enthusiasts often refuse to use life jackets, claiming they are cumbersome and impractical But they seem to feel differently about a recent flotation device called Aqua Buoy Manufactured in West Germany this invention is the size of a matchbox and worn on the wrist If you run into trouble just tug the yellow trigger ring This causes a carbon dioxide cartridge to inflate a nylon pillow that can keep a 300 pound person and/or equipment afloat for a week

The device which costs only $19 95 became popular with wind surfers during a recent international regatta in Florida They attached the buoys to their sailboards to ensure easy recovery of the boards when the surfer and board parted company. John Fleming, Aqua Buoy's marketing director says that the U S Lifesaving Association has endorsed this device In addition, officers of the Houston police department now carry Aqua Buoy as part of their gear "It isn t intended to take the place of a life jacket, says Fleming "It s something to hang on to if you're too tired to swim "

—George Nobbe

A cynic is a man who, when he smells flowers, looks around for a coffin' —H L Mencken

It's all on the wrist With a mere tug on a ring this tiny package could save [illegible] and keep you afloat [illegible] a week

CONTINUUM

Star shiny star bright why can t I see you at night? Will astronomers overcome the light-pollution problem?

KEEPING AN EYE ON ALPHA CENTAURI

A "grass-roots coalition of astronomers and educa tors, headed by Arthur Vaughan ot the Jet Propulsion Lab, is taking over operation ot the 85-year-old Mount Wilson Observatory in Californ nia The previous administra tor abandoned the observa tory because light pollution from Los Angeles made it impossible to view distant objects Despite this Mount Wilson is an excellent site tor observing nearby stars

Mount Wilson offers many advantages. The sky is clear on average 300 nights per year a figure unsurpassed by other observatones in this country Curiously, the same conditions that lead to smog and temperature inversions in the LA basin make tor a stable atmosphere and, consequently better viewing ot nearby stars

Because Mount Wilson is an older facility, there is less competition for observing time enabling astronomers to establish long-range pro grams spanning years rather than weeks "You can look at stars every single night, which is important it you want to study variations," says Sallie Baliunas ot the Harvard–Smithsonian Center for Astrophysics 'Full-time access allows you to do a new kind of science '

Among other projects, Mount Wilson astronomers will study star cycles—knowledge that could help them predict sunspot cycles and how sunspots and solar flares affect the earth s climate 'There is some romance in being able to see farther and farther, peering out to the origins of the universe ' says Bob Eklund ot the Mount Wilson Observa tory Association 'But in the course of doing that, we ve forgotten to look at our own backyard ' —Steve Nadis

I wonder that a soothsayer doesn t laugh whenever he sees another soothsayer '

—Marcus Tullius Cicero

' I got the bill for my surgery Now I know what those doctors were wearing masks for '

—James H Boren

KRAZY GLUE SUTURES

It s the stuff that binds broken vases cements model airplanes, and seals fake lashes onto eyelids But now the same adhesive found in Krazy Glue is being used to close facial cuts and surgical incisions

Indeed the new ' tissue glue may soon replace stitches as the surest way to mend cuts in the skin without leaving a visible scar Developed in Europe and currently marketed there and in Canada (it's not yet available in the United States) the glue is made of a tough sticking compound called Histoacryl According to H George Brennan M D president ot the Foundation for Facial Plastic Surgery in Newport Beach California surgeons have always been savvy about the strengths ot using Krazy Glue to seal microscopic tissue holes they couldn t mend with a stitch Now that basic formula has been refined for surgical use

"I use it primarily for face-lifts, eye lifts and ear repair " says Brennan ' But it can also be employed for facial lacerations if the edges of the skin meet without being pulled together '

Most plastic surgeons stitch underneath the skin to avoid the familiar "railroad track" scars But even this can leave behind tiny depressions known as su ture tunnels ' Tissue glue can replace stitching altogether in very small incisions or it can allow surgeons to remove stitches earlier (before scar tissue forms around the thread) 'It s particularly good for closing cuts on a child's face, ' says Brennan "It saves the child from the

A stitch in time may save nine but a dab of glue won t scar

traumatic ordeal of getting a cut stitched up and then returning to have the sutures removed a few days later

Currently only about 100 plastic surgeons in the United States are using Histoacryl but Brennan predicts that once this liquid cement is marketed here more surgeons will start laying down their sewing needles

—Ellen Kunes

"An ounce of image is worth a pound of performance"
—Laurence J. Peter

"Pity the meek, for they shall inherit the earth."
—Don Marquis

SAY GOOD-BYE TO KIRTLAND'S WARBLER

The Kirtland's warbler is a tiny, yellow bellied bird with a big voice indigenous to the forests of North America. It may also be the first species doomed to extinction by the greenhouse effect—a harbinger of environmental destruction yet to come.

So says Daniel B. Botkin, a professor of biological sciences and environmental studies at the University of California, Santa Barbara. He and a team of researchers have been charting the global warming trend (caused by the buildup of carbon dioxide and other gases in the earth's atmosphere), and he now projects that temperatures will rise so rapidly that the Kirtland's warbler, along with other endangered species, may not be able to adapt to its warmer habitat quickly enough to survive.

Botkin says a rapid decline in the warbler population may signal that the greenhouse effect is happening and starting to do damage.

Scientists now estimate that the greenhouse effect may raise the world's temperature an average 6° to 12° F within the next 100 years. Such a profound warming trend would dramatically alter the types of trees that grow in North American forests. For instance, explains Botkin, the spruce, pine, and fir trees—used to make lumber and paper products—of Michigan, Minnesota, and Wisconsin won't be able to grow in the warmer weather and will eventually be replaced by the kinds of trees now used to build furniture, such as sugar maple, beech, and yellow birch. Botkin also predicts that large areas of forests may become "shrub land" in the interim.

How does all this change affect the Kirtland's warbler? "These birds nest at the southern edge of the jack-pine forests in Michigan," explains Botkin. "If our projections are correct, the expected climate warming will prevent the one hundred twenty-seven thousand five hundred acres of jack-pine woodland, which is quite sensitive to changes in weather, from regenerating," Adds Botkin, "And without jack pine, the warbler can't survive." —Ellen Kunes

Greenhouses conjure up comforting images of flourishing plant life, but the greenhouse effect promises to kill off plants, trees, and the life they support

"Suburbia is where the developer bulldozes out the trees, then names the streets after them."
—Bill Vaughn

CONTINUUM

BRAINY CHIP

Neural nets computing systems that are modeled on the human brain are already able to read DNA code sequences recognize bad bank loans and navigate robots around obstacles in an enclosed environment But progress has been restricted to software simulations Developing the hardware to go with the software has proved more difficult Recently, however New Jersey scientists Josh Alspector and Bob Allen who work at Bellcore the research arm of the Bell Operating Company, unveiled a neural network computer chip modeled on brain neurons that is capable of learning tasks with astonishing speed

The chip "learns in two stages First the chip is fed information and responds to it in a tree-form fashion This is followed by a teacher phase in which the chip s output is electronically shaped into a correct response Learning is achieved by strengthening and weakening some of the 15 transistorized connections in a manner similar to the way brain cells learn 'With a small number of examples Alspector comments 'the chip will begin delivering the correct answer spontaneously" And it does so in a matter of milliseconds—100,000 times faster than previous computer simulations of neural network models

Alspector and Allen's success raises the possibility that such chips could be used to add specialized functions to future computers In addition it may be the first step toward building computers that can recognize and process the spoken word at the same near instantaneous speed with which present-day computers do arithmetic —Jeff Goldberg

A chip off the old block The [illegible] a computer chip that learns without n[illegible]

'The brain is as strong as its weakest think
—Eleanor Doan

' Small rooms discipline the mind large ones distract it "
—Leonardo da Vinci

AIDS ANXIETY

A twenty-year-old college student who was engaged to be married visited a prostitute in an effort to gain some experience before his wedding night Although he had no sexual contact with the prostitute after the encounter he became obsessed with the idea that he had contracted AIDS from simply being in the same room as the woman He was unable to sleep eat or concentrate on his studies Finally in desperation he decided to see a psychologist

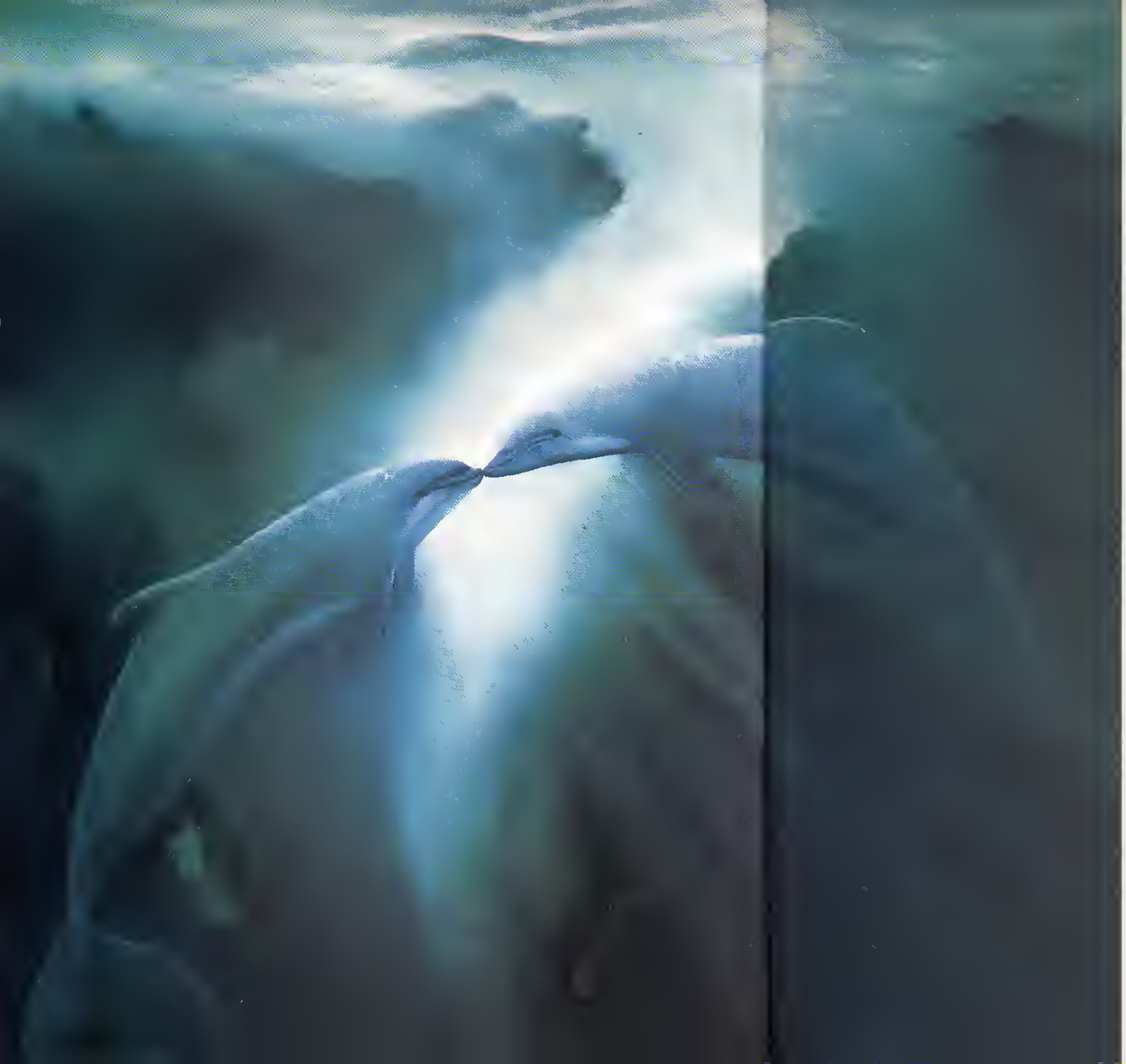
It makes sense that people would worry about becoming infected with the AIDS virus, but as with other serious diseases some people who don t fit the high-risk profile, like the man above have begun to panic

The typical case says Dr Andrew Brotman, a psychiatrist at Harvard Medical School 'is the single person who has had more than one heterosexual contact and is looking back on his or her life or a married person who has had an extramarital contact In the latter case the guilt over past sexual activity merges with the AIDS threat to produce anxiety

These patients 'spend much of their day ruminating about this " says Brotman, and even multiple negative AIDS tests will not allay their fears Brotman has found that many of the patients are suffering from depression or some other underlying psychological problem that is fed by the public distress over the AIDS epidemic Antidepressant drugs notes Brotman may alleviate the problem in some cases

National surveys have not yet been done so Brotman is uncertain about the scope of AIDS anxiety But he says It is a common enough phenomenon that therapists are likely to run across at least one person who has it —Paul McCarthy

"Even paranoids have real enemies
—Delmore Schwartz



ARTICLE

From nurturing health to the search for extraterrestrial life, these "alien" beings may prove to be man's equal

THE DAY OF THE DOLPHINS

BY JUSTINE KAPLAN

Off the shores of Carlsbad, the surf is teeming. Boys in neon wet suits push their way past breakers, their sleek boards glistening in the Southern California sun. From the beach a school of dolphins can be seen among them, rolling in the swells, waiting. When the right wave hits, the crest is a flurry of dorsal fins and sandy-haired surfers, as aware of one another's presence as the most serious of competitors.

In our own oceans lives a sentient being, a creature perhaps as curious and communicative as we are. Torpedo shaped and alien as Martians, 66 species of dolphins, porpoises, and other toothed whales inhabit the earth's waters, detecting sound through their jaws and breathing from openings on the tops of their heads. It is perhaps irresponsible to draw comparisons between man and a 300 pound, hairless marine mammal with skin like a wet inner tube. But stare into the eye of a dolphin and some bit of information is exchanged, some mutual yearning happens. There is a reflective glint, a hint of wisdom.

From the beginning of time the dolphins remarkable abilities have been extolled by poets, philosophers, and historians as well as by the ancients whose legends tell that dolphins were really men transformed by the gods. Only in the last decade, however, have researchers in the field of cetacean behavior begun to determine how intelligent these aquatic sages truly are. Scientists analyzing the dolphins' communication systems are working to decode their verbal and

PAINTING BY GEORGE SUMNER

nonverbal signals Researchers are attempting to determine how echolocation—the complex sonar communication system dolphins use to navigate their undersea world—can be used to protect them from their greatest threat the tuna net. Cetacean scholars from Florida to Australia are studying the dolphins complex familial and social relationships And in the laboratory, neurologists are attempting to unravel the mystery of the dolphin brain, an organ quite different in function from man's but with a creativity center larger than our own While most of the research focuses on understanding the communication systems and minds of these animals more recent and perhaps riskier studies include using dolphins as an adjunct to treating a wide variety of human ills from autism to cancer

Every Tuesday at the Dolphin Research Center in Grassy Key, Florida psychologist David Nathanson relies on six Atlantic bottle-nosed dolphins to help bolster the speech and memories of mentally handicapped children At the center which is devoted to 'mutually beneficial human–dolphin interaction' the dolphins swim with are cuddled by and aid in teaching handicapped kids

Nathanson is finding that the children pay closer attention and learn up to ten times more quickly in these surroundings than they do in classrooms where their usual reward is verbal praise and a hug or a kiss "They prefer a kiss from the dolphins to a kiss from me,' says Nathanson. 'I'm not insulted by this," he adds During some lessons pictures displaying simple words such as *bus* or *dog* are tossed to the dolphins, which bring them to the children If the child pronounces the word correctly, the reward is a swim with the dolphins

Nathanson recalls that when a six-year-old quadriplegic boy dangled his legs in the water a female dolphin named Little Bit, one of the original dolphins in the *Flipper* television series, "zoned in on him and nuzzled him gently It was striking The dolphins seem to sense these kids are handicapped Nathanson adds 'They perceive these children as a little more helpless than the people they usually swim with, so they're gentler "

A second facility devoted to human–dolphin interaction is Dolphins Plus, a private 'dolphinarium" with a grassy waterfront at the edge of two adjoining pools forming a lagoon in Key Largo Florida In the summer of 1987 the owners turned over the facility for eight days to Betsy Smith, Ph D , an associate professor of social work at Florida International University in Miami Smith, who has been working in animal-assisted therapy for 15 years and was the first to try dolphin therapy in 1971, wanted to test her theory that autistic children who had not benefited from other types of treatment might become more sociable and communicative by being with the dolphins

Ten years ago Smith began studying the responses of neurologically impaired children to dolphins and found that those children with autism responded most dramatically "Dolphins, who have no preconceived expectations approach an autistic child as they would any other—for spontaneous interaction," says Smith 'And if you're going to work with dolphins, there better be a good reason so that it isn't exploitation You have to show me that dogs and cats don't work "

While the children's social skills appeared to improve after spending time with dolphins, Smith admits she has not proved that the dolphins rather than the therapeutic effects of water are responsible for her success But she says the children who spent time with the dolphins appeared to be more energetic and motivated than a control group that was taken to swim at another beach Questionnaires and interviews with parents have shown that the "dolphin kids' demonstrated long-term behavioral and social changes and she plans to test these results further in a follow-up study

> *"Herman has shown that dolphins understand the meanings of words in their languages and how word order affects those meanings, a trait that is considered the core of most human languages"*

For years researchers have been examining the effects of stress and depression on the immune system Terminal cancer patients have reduced the size of their tumors by imagining their cancer cells are dark forces of evil being overcome by fighting white knights Stephen Jozsef of Living From the Heart, a nonprofit institute in Parker, Colorado, believes that allowing cancer patients to interact with dolphins might have much the same effect Jozsef recently flew 15 cancer patients to Florida to swim with dolphins at the Dolphin Research Center Dolphins, Jozsef thinks, exist in an alpha state—a meditative condition associated with creativity, intuition, and perhaps the potential for self-healing He believes that by swimming with dolphins humans can enter that state, making it possible for them to tap their own healing powers He hopes to use biofeedback to teach patients how to re-create that meditative alpha state and plans to conduct comparative studies of blood chemistry and brain waves in patients before and after they swim with dolphins 'The scientific community," he says, "needs data'

As much as it needs raw data, the scientific community also needs proof that can be replicated. For years the field of cetacean research was tarnished by unsupported and unrealistic claims—among them that dolphins can speak English, heal wounds with their sonar and save drowning swimmers Skepticism about dolphin work increased in the Sixties when the infamous Dr John C Lilly, a neurophysiologist and psychoanalyst, speculated that the cetaceans used their enormous brains to develop their own language culture oral history philosophy and system of ethics Despite Lilly's early ground-breaking attempt to map the dolphin brain, his advances were undermined by his unorthodoxy He tried to teach the dolphins English and proposed equipping their tanks with telephones so that they could converse with their relatives in the wild Lilly also took to downing hallucinatory drugs so that he might enter what he believed was the dolphins' higher state of consciousness "He got involved with drugs and spent an increasing amount of time trying to understand this world of illusion, drifting away from reality altogether," says Kenneth Norris, a field biologist at the University of California at Santa Cruz who has been studying Hawaii's wild spinner dolphin for three decades 'He started out as a capable scientist, but nothing he did was subject to measurement or truth, and that's what scientists live by "

Most cetacean scientists agree that the person who has given scientific credibility to the field is psychologist Louis Herman, director of the University of Hawaii's Kewalo Basin Marine Mammal Laboratory "Herman is a real titan in the area His work is the very backbone of the field of dolphin cognition," says Norris "He has almost single-handedly defined the capabilities of the dolphin mind" For the past ten years Herman and his colleagues have worked with two Atlantic bottle-nosed dolphins Phoenix and Akeakamai, methodically testing their ability to understand and execute commands in two kinds of artificial language Phoenix's language consists of electronically generated computer whistles Ake's is based on hand and arm gestures Each language has a 'vocabulary' and a set of rules governing how the sounds or gestures are arranged in sequences that form thousands of sentences Using these languages, Herman has shown that dolphins understand the meanings of the words in their languages and, even more important, how word order affects meaning This ability is considered to be at the core of most human languages, a trait many linguists and philosophers would argue is a sign of intelligence

Herman has discovered, for example

that dolphins can differentiate between phrases such as 'Pipe fetch surfboard'—which translates to "Get the pipe and take it to the surtboard"—and 'Surtboard tetch pipe' which means 'Get the surtboard and take it to the pipe'.

The commands are issued in two different ways: through a set of computer whistles broadcast through an underwater speaker, and through a series of hand and arm gestures. For the latter, a trainer stands at tankside, wearing dark goggles to control unintentional visual cues. The trainer then makes a series of gestures that construct a sentence.

Some scientists have argued that it is misleading for Herman to call what the dolphins have learned 'language.' David Premack, a former ape researcher at the University of Pennsylvania, who has retired from his animal language work, claims Herman's "free use of a sentence" is a problem. Human language, he argues, consists of abstract concepts, not just objects and actions. And a decade ago Columbia University psychologist Herbert Terrace published statements that ape language researchers were incorrect, that animals learned not language but behaviors—behaviors that earned rewards.

Herman retorts that "the fact that an animal gets a reward does not invalidate the involvement of language." Furthermore, Herman contends that dolphins 'develop an understanding of the words of their language at the level of a concept.' For example *under* means passing beneath, and dolphins will raise an object from the tank bottom to swim below in response to *under*. He has also demonstrated that dolphins understand references to absent objects. When asked 'ball question,' which means 'Is there a ball in the tank?' Ake searches the pool and responds on a "yes" or "no" paddle. When the dolphin presses the "no" paddle, it implies she has understood the sign, formed a mental image of the object referred to, and deduced the ball is not there. This ability—called referential reporting—has previously been documented only in apes and man.

Herman's laboratory sounds more like an aviary than a marine habitat, filled with a cacophony of creaky clicks, squeals, and high-pitched whistles. A new venture will be to identify which dolphin is sending these sounds and which is receiving them. It is a difficult task, as dolphin sounds are produced in the region of their blowhole and emitted through the head without any visible indication.

In a preliminary study conducted with Peter Tyack, an assistant scientist at Woods Hole Oceanographic Institute, Herman and his colleagues attached to the head of a dolphin, using suction cups, a primitive contraption called a vocalite—a device developed by Tyack that lights up whenever a dolphin makes a sound. With the aid of Richard Ferraro, a senior scientist at the Institute of Applied Physiology and Medicine, Herman is developing and testing a more sophisticated instrument. A microcomputer, it is fastened by suction cups to each dolphin's head. It records each sound and offloads the time of every vocalization into a second computer. These recordings will be analyzed to determine which dolphin was communicating, what the sounds were, and what behaviors were occurring at the time.

Scientists have known since 1965 that dolphins have distinctive signature whistles, which they use to identify themselves. Tyack's work showed that the animals were actually imitating one another's whistles. "Learned mimicry is rare in the animal kingdom, but dolphins can be trained to imitate particular sounds, and wild dolphins appear to use this skill to imitate each other's whistles, perhaps to initiate social interaction," says Tyack. With support from the Office of Naval Research in Arlington, Virginia, Tyack is studying the social function of the whistles by recording the sounds of captive dolphins at the New England Aquarium and Chicago's Brookfield Zoo. Tyack is also analyzing the signature whistles of a wild dolphin population followed in Sarasota Bay, Florida, for the past 19 years by researcher Randall Wells.

Five months out of the year Wells, along with guest researchers and volunteers from Earthwatch, a nonprofit research organization, tracks the Sarasota dolphins to understand how they divide themselves into subgroups. The dolphins are captured for short periods of time for identification and sampling, during that time Tyack records the whistles of each dolphin handled, including those of pairs that have bonded together, such as mothers and calves.

Wells has recently expanded his population studies to the Tampa area. Since he began his study in 1970, Wells has identified nearly 600 individual dolphins from Florida's central west coast and has determined that the populations segregate themselves into groups. It appears that adult females with calves form bands that may include three generations of females as well as some unrelated females. It has also been established that the adult females seen briefly accompanying calves may not be their own mothers but "baby-sitters." As dolphins mature, Wells and his colleagues have found, they join sex-segregated groups. Within those groups, males form pair-bonds with other males for years at a time. A similar study by a group of University of Michigan graduate students at Monkey Mia, a remote bay in northwestern Australia, has shown that the male pairs often herd or 'kidnap' females for mating. This bonding, which Wells says may be as tight as female–calf bonds, may give male dol-

'Come to your senses, professor Fernberg. We did not transcend the time–space continuum. We got drunk in a topless bar.'

phins the group dynamics they seem to need, as well as protection from sharks.

By recording age, sex, births, and deaths as well as sexual maturity and reproductive patterns of the Florida dolphin population, Wells hopes to gain an in-depth understanding of the dynamics of a wild population. One practical application: to compare his data with those of scientists doing studies in captivity to determine whether wild and captive dolphins grow, mature or reproduce at different rates. He is also studying the changes that occur in dolphin blubber depths, "overcoats" that vary in thickness depending on water temperature.

Working with Deborah Duffield, a biology professor at Portland State University, Wells is using state-of-the-art genetic techniques to determine the genetic makeup of the Sarasota population. Currently, dolphin mating systems are undefined, and paternity has been almost impossible to establish. By combining the genetic information with observations of interactions between males and females, Wells is hoping to see if or how fathers interact with their relatives. Wells has already found evidence that the Sarasota populations interbreed with other adjacent populations. The extent of this interbreeding will help determine whether the populations interact to recover from natural disasters such as red tides or human intervention such as capture or coastal development.

The greatest threat to dolphins, however, is the tuna net. While the Marine Mammal Protection Act has been amended to limit the number of dolphins "accidentally" killed by fishermen, enforcement is lacking. Scientists studying dolphin sonar (sound navigation and ranging) as well as their schooling systems are attempting to develop ways to save them from the nets. The sonar, or echolocating, blasts are actually short bursts of sound pulsing through the fatty tissue of the dolphin's forehead or melon, where they are focused into a beam that travels through water 4.5 times faster than through air. When the sound is sent, it bounces off a target and returns an echo containing information on the surrounding environment. The dolphin hears through fat deposits in its jaw from which sound is transmitted to the inner ear and then to the brain. A broad band of low- and high-frequency sound emissions, which bounce off or go through fish and other animals like an X-ray, lets dolphins navigate in turbid waters and locate and identify objects well out of visual range, up to 800 meters away.

There has been some speculation that dolphins may use their sonar to project images into other dolphins' brains. Perhaps sonar also gives dolphins an understanding of the humans that enter their environment. Pregnant women have reported that when they are in the water with dolphins, they can feel blasts of energy directed at their wombs. The echolocating beams are gentle, soothing vibrations that feel like energy pulsing through a machine.

Ken Norris, who identified the dolphin sonar 40 years ago, believes that some of the sounds are powerful enough to kill fish. "When the dolphin gets near a fish, there's a loud bang, two hundred to five hundred times as long as a regular echolocation click," he says. In experiments in his laboratory, Norris has killed anchovies with simulated feeding sounds.

Even with such a fine-tuned sonar system—a dolphin can detect a vitamin capsule from the far end of a large pool—dolphins are still unable to sense fishing nets. Given that deficiency, Norris has proposed a way to release dolphins from tuna nets based on his studies of the mechanics of the dolphin school. In vast regions of the tropical Pacific, prized yellowfin tuna are often found in the company of spotted, spinner, and common

"Pregnant women report that while in the water with dolphins, they feel blasts of energy directed at their wombs. The beams are actually vibrations that feel like energy pulsing through a machine."

dolphins, an association that has helped to build a billion-dollar fishing industry. Fishermen locate schools of tuna by spotting dolphins, then herd the tuna and dolphins into a bunch and drop a large net around them, which they shut at the bottom and winch in. Although they attempt to release the dolphins while keeping the fish, the dolphins become disoriented and entangled in the nets, where they suffocate and drown. Approximately 125,000 dolphins are killed by fishermen each year.

By understanding the dolphin schooling system, which he calls a "magic envelope," Norris believes a method can be developed to release dolphins from the nets. One function of the school, says Norris, is the "chorus line effect"—an intricate system that allows dolphins to evade sharks. As each dancer on the chorus line anticipates the kicks of his or her neighbor, Norris explains, so does each dolphin foresee the moves of the others in its school and then act in concert with them.

Caught in a tuna net, dolphins are "stripped of this magic envelope," says Norris. Their school system does not work when they are pressed together in a net. To release them, we have to design a way to let that magic envelope out intact and maintain the spacing of individuals." Norris and his colleagues are now trying to define the shape of a net opening that would allow dolphins to maintain their signaling systems.

In Hawaii in the late Seventies, Norris tested his theory by encircling schools of dolphins in nets with 12-foot openings and found they wouldn't go out. At 20 feet, some of them did. This summer and fall, Norris and his colleagues are testing the configurations of net openings to determine the size of the opening required to let the entire school escape.

It would seem that a creature with a brain approximately the same size as man's could figure out how to avoid such trouble. Its keen sense of hearing did, after all, evolve to compete with the shark's acute sense of smell.

It's a strange combination of abilities and inadequacies that has led to the fascination with the dolphin's big brain. In humans the part of the brain known as the neocortex is considered the seat of creativity and thought. In man the total cortical surface is 96 percent neocortex; in the dolphin, 98 percent. But despite the similarity in size between the neocortices of man and dolphin, in other ways they are quite dissimilar.

This brain has come down a very different path evolutionarily, and the cortex has remained much more generalized than those of more modern land animals," says Peter Morgane, senior scientist at the Worcester Foundation for Experimental Biology, who with Ilya Glezer, an anatomy professor at the City of New York Medical School, has pioneered studies of dolphin neuroanatomy. Before the mid-Sixties it was difficult to study brains of cetaceans because it was impossible to conduct surgical procedures on these voluntary breathers. A dose of anesthetic acceptable to land mammals would kill a dolphin instantly. In 1963 Morgane, with anesthesiologist Eugene Nagel and Forrest Bird of the Bird Respirator Company, designed a respirator that mimicked the pulsatile breathing pattern of this diving animal. And they created a nitrous oxide mixture to put dolphins into a state of general anesthesia. They and others, primarily in the Soviet Union, have succeeded in mapping portions of the dolphin brain—especially the cerebral cortex, which has been mapped using recording electrodes implanted in anesthetized specimens.

What the dolphin neocortex has done evolutionarily, says Morgane, "is get bigger but it doesn't seem to have gotten more complex. It has a very ancient type of organization, and we don't see this type of arrangement in any modern land animal. The dolphin has kept the brain it had when it first went into the water some fifty

CONTINUED ON PAGE 94

ARTICLE

A CAVE DWELLER'S CHRONICLE: FIFTY-SIX DAYS AND COUNTING

BY ALCESTIS OBERG

Inside Lost Cave, New Mexico, there is no sunlight. There is no wind to blow the window curtains, cut from blue-colored paper and taped onto the wall of Stefania Follini's small home, a nine- by twelve-foot Plexiglas module. A paper sun is taped up, so is a paper cat that looks like it's sitting on a ledge. Paper grass "grows"; a bowl of paper fruit and paper bread adds some cheer to the small place. Outside the

PAINTING BY BRAD HOLLAND

window a paper crescent moon and a few paper stars keep unmoving vigil over the solitary occupant. The only forms of life are crickets, tiger salamanders, red-spotted toads, and an occasional mouse. It's too cold for snakes.

Small in build, quiet, almost serene, the twenty-seven-year old Italian volunteered to imprison herself in Lost Cave for nearly five months. By profession a designer who advises people on how to arrange interior spaces, Follini began her solitary venture on January 13, 1989. When Pioneer-Frontier Research and Explorations, a nonprofit organization based in Italy, sought a place for Follini's experiment, Lost Cave, one of approximately 600 caves in southeastern New Mexico, seemed perfect. Twenty-five feet deep, it is dry, with a relatively constant temperature of about 68°. The "great hall" in the cave is 150 feet long with an average ceiling height of about 13 feet. The Italian foundation has already conducted a number of cave experiments in Europe. In one experiment 15 people lived together in a cave for 45 days.

Maurizio Montalbini, the director of the organization, holds the *Guinness* world record for staying in a cave—210 days. Today he hopes to interest NASA in a cooperative experiment involving three to eight people dwelling in a cave for 12 months—the time it would take to fly to Mars. According to Montalbini, the purpose of Follini's experiment—called Frontera Dona (Frontier Woman)—is to study the psychological and physiological effects on a human deprived of all time measurements and cues—clocks, sunrise, sunset. Artificial lights in the cave can be turned down but not off, so she can't create her own time cues.

Follini wears a blood pressure monitor, providing data that are analyzed at the University of Minnesota by Franz Halberg, the father of chronobiology and the man who coined the term *circadian rhythm*. This is the first continuously run blood pressure test on a person in isolation. Follini takes her temperature four times a day, collects her urine, an important indicator of calcium levels, and draws her blood every couple of weeks, sending the urine and the blood vials through a hose connected to a trailer aboveground. The team sends the vials of blood, Express Mail, to laboratories to check her hormone levels, stress indicators, and red and white blood cell counts. Some of her blood is immediately frozen, and after the experiment is completed, her calcium levels as well as her urine samples will be analyzed. Periodically she hooks herself up to an electroencephalograph (EFG) to measure the electrical activity of her brain, its alpha and beta waves. Sometimes when she sleeps, the crew tests her REM (rapid eye movement) sleep patterns. Occasionally she's asked to take a battery of tests that NASA, the Air Force, and the Navy use on pilots to determine reaction times, pattern recognition, and fine motor functions, such as finger coordination.

Follini feeds this and other information by computer to the crew aboveground—Montalbini, his wife, and team physician Andrea Galvagno—who monitor her 24 hours a day. When the crew wants to communicate with her, they beep her. They can hear her talk and sing, but she cannot hear them. A black-and-white camera, affixed to the wall of the cave, provides a full view of her module. One camera situated inside the module catches Follini's every move. The inside camera, positioned a few feet from the computer, surveys Follini as she types out answers to questions from the crew. When reporters or researchers interview her in the cave, she can turn and look directly into this camera, laughing, gesturing, or smiling at people she cannot see.

Follini's home is designed like a small spacecraft. There is an entrance area, similar to an airlock, where Follini cleans off dirt when she comes back into her module from the cave. Outside the module, there's a tiny bathroom with a toilet and mirror but no bath—only towels for washing. The hose through which she

sends her blood is in the cave, so are bottles of water for drinking and bathing and replacement cans for the toilet. She stores the toilet's filled containers in the cave. The team figured out how much food and water she would need for the five months. Nothing will be resupplied. Inside the module are a small worktable, medical equipment for blood tests, the computer, and a wall of shelves. Follini took 400 books with her, a guitar, a diary, and, being a vegetarian, plenty of cereals, legumes, dried fruits, and seaweed.

The Carlsbad area—where Lost Cave is located—had been an underwater reef 250 million years ago, near the coastline of the North American continent. After about 60 million years the limestone compacted, then cracked, and water began to seep underground. The acid content of the water ate away at the stone, carving out embryonic caves. The steady drip of water—over thousands and thousands of years—formed the dramatic stalagmites for which Carlsbad Caverns is famous. Then about 12,000 years ago, the area turned into desert. The caves became dormant, awaiting the rains and fresh water that would create more eerie underground sculptures.

Prehistoric animals—saber-toothed tigers and ground sloths—lived in the entrances to the caves. A tribe of prehistoric Native Americans, the Guadalupe Basket Makers, inhabited the area as early as 4,000 years ago. The Mescalero Apache, who live on a reservation in the Sacramento Mountains, displaced the Basket Makers around A.D. 1400.

Although the rocks always project a feeling of power and strength, cavers and park rangers alike are quick to point out that caves are among the most fragile of Earth environments. The carbon dioxide people exhale, the dust turned up by footsteps, can change the underground environment. Despite their appearance, they are delicate, as fragile as the tiles on the mighty space shuttle.

On January 4, 1989, I met Follini at the Johnson Space Center medical clinic in Houston, where she was completing a medical workup before entering Lost Cave on January 13. She was wearing glasses, very little makeup, and casual clothing. We talked in the hall through the team's translator, Rita Fraschini.

Omni: What factors motivated you to try this experience?

Follini: My short-term goal is simple: to know myself better, to learn more about myself, to test my ability and capacity to live alone in an environment such as a cave. I really hope, in the long run, that I will experience life differently: that I'll have a better life. I want to love myself more, and that will help me to love people around me more.

Omni: What do you dislike in life?

Follini: Noise. People who are in a hurry.

Omni: Are you religious?

Follini: I believe that God is infinite. He's inside of everyone, not far away.

Omni: Are you going into Lost Cave because you want to contemplate?

Follini: I'm going in to concentrate—not contemplate. I don't need to solve any problems, but I want to put myself in a condition to solve problems.

Omni: As a child, did you spend a lot of time alone?

Follini: No. In fact, it seemed like I had no privacy. Somebody was always around, even though I am an only child. My father, mother, grandmother, and I lived in a big house with a garden.

Omni: Professionally, you're an interior designer. Did you decide to live in a cave to test the amount of space that a person needs to feel comfortable?

Follini: I'm intrigued by small places. I like small spaces. If the space is rationally set up and well designed, living in a small space should be a beautiful experience.

Omni: You are somebody's daughter, colleague, girlfriend. Will you feel free of these human relationships or do you expect to be lonely?

Follini: I expect to feel free of all relationships. I'll take time in the cave to evaluate my relationships, to learn to see people in my life from afar. I expect to feel lonely.

Omni: You're the first woman to perform this experiment. Do you feel pressure to be successful?

Follini: Sure. I feel pressure and responsibility, but not because I'm the first woman. The pressure is within myself.

Omni: Have you had any dreams about your upcoming experience?

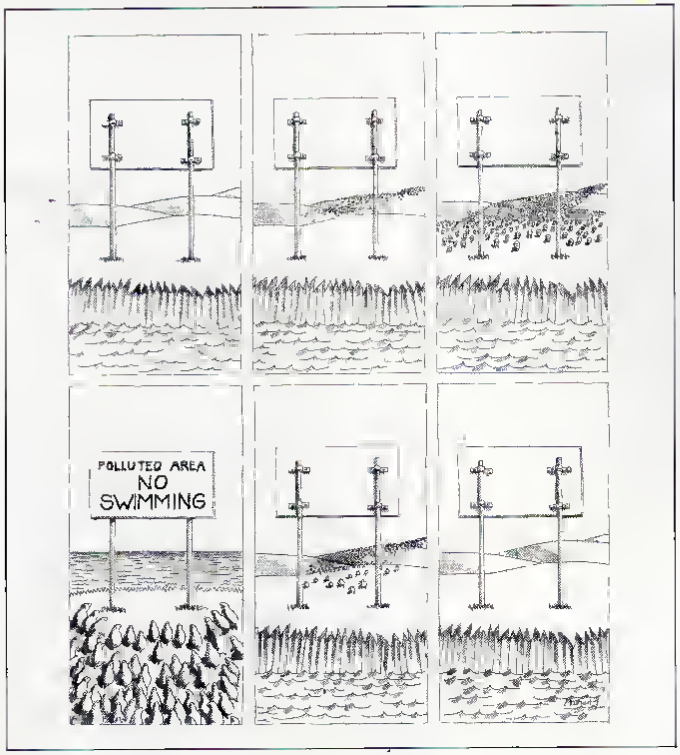
Follini: I've been dreaming about this for four months. In one dream I'm in a castle that has a big heavy door. The castle is dark and looks like a cave. As I approach the door at the opposite end of the hall, I see ferocious dogs everywhere. But it's okay. I do reach the door.

Omni: Only nightmares?

Follini: No, recently I had a wonderful dream about a woman. The dream was triggered by an archaeological find, the skeleton of a woman who anthropologists say is Eve. I am in a cave contemplating her bones, studying her skull. Somebody tells me who she is, her life story. Her name is Lucy. In Italian, *Lucy* means "lights."

Omni: Picture yourself emerging from the cave six months from now.

Follini: Faces. I picture the faces of my family and friends.



Follini entered Lost Cave, New Mexico, at three in the morning on January 13, 1989. Montalbini decided that going in and coming out of the cave in darkness would be less traumatic. The research team accompanied her into the cave. The occasion was festive. They left Follini at 5:15 in the morning.

When she was first locked in the cave,

she experienced some vertigo. Montalbini—and scientists at NASA's Space Biomedical Research Institute—are particularly interested in what happens to the bones of a person completely cut off from all sources of vitamin D, a vitamin essential to absorption of calcium by the body for bone renewal. Follini received a complete calcium workup and skeletal survey before she entered the cave. Even her dried milk is vitamin D free. These tests will be rerun when she finishes the experiment. (According to Joseph Degioanni, a medical officer at the space agency, NASA is not officially supporting Montalbini's experiment. The Biomedical Research Institute scientists are working independently of the agency.)

Within a few days after entering the cave, Follini's biorhythms began to drift, moving from a 24-hour day to a 28-hour day. She tended to go to bed later and later. Throughout January she awoke between six and nine in the morning. By early February, she awoke anywhere between noon and two in the afternoon, and by the end of February, she was waking up around eight in the evening.

On February 27, she went into a sudden, drastic biorhythm shift. She awoke at one in the morning and went to sleep at one in the morning the following day. On March 4, she woke up at 6:30 in the morning and went to sleep March 5 at noon. She had shifted from a 28-hour cycle to a 44-hour one. Galvagno noted that the proportion of sleep was the same. She still slept one third of the time. She was losing weight, however, because she was eating three meals a day for a 44- rather than 24-hour cycle. Another researcher, John DeFrance, a neuropsychologist at the University of Texas Medical School, noticed that her REM sleep had begun to occur earlier in her sleep cycle, a symptom sometimes associated with depression. She had had only one menstrual period in 53 days.

Follini had begun to perceive a 14-hour sleep as a two-hour "nap." The *Omni* interviews took place during this severe biorhythmic disruption. Because she knew I was going to interview her in the middle of the experiment, I was identified as Montalbini in the first interview and as a group of journalists and psychologists in the second. The research team did not want to give her any time cues.

In the cave, through the camera, I saw Follini's wide range of emotions—anger, irritation, sadness, distress, happiness, laughter—the very picture of human vulnerability, laying bare the psyche's own brutal rhythms. Follini is a pioneer, experiencing the burden of solitary exploration. If she completes the entire 150 days, she will have lived alone in a cave longer than any other woman has dared.

Aboveground, Tuesday, March 7 was a beautiful spring day. The sky was the absolute blue of the Southwest, and the sun went briefly into partial eclipse around noon. The temperature was 70°. Park rangers at nearby Carlsbad Caverns National Park noted that the migrating birds had begun their northerly pilgrimage. Various cacti and grasses had begun their spring bloom in the rocky white soil of the semidesert region. The time: 5:30 in the afternoon.

Omni: What day is it today? What time?

Follini: It is Sunday, February 12, 1989, four o'clock in the morning.

Omni: What was your first impression of the cave?

Follini: Intimate, pleasant, discreet, reserved, warm—even if it's not spectacular. I liked it.

Omni: When you said good-bye to the world, how did you feel?

Follini: [hand on her face, thinking a long time before she answers] My good-bye to the world lasted, perhaps, more than a year, but for sure from the time the countdown started in November 1988. I felt a great sorrow when I thought about leaving the world. But this pushed me to love life even more, to live more intensely—even if detached—as if I were unglueing [splitting] from reality. I enjoyed every moment, trying to retain in the eyes all the images, in the ears all the sounds. I remember every handshake, every pat on the shoulder.

In Rome, the night before I left, I said good-bye to the last Italian faces, to my friends at the gymnasium where I work out, to my parents, and to the last gorgeous sunrise of the twelfth of January. I looked at everything as if it were for the last time. The value of life was overturned. What was meaningless started to become very important, what had always been important became a trifle.

Omni: Go back to the last week before you entered the cave. Did you go through various stages of letting go—anxiety, sorrow, acceptance and desire to enter the cave?

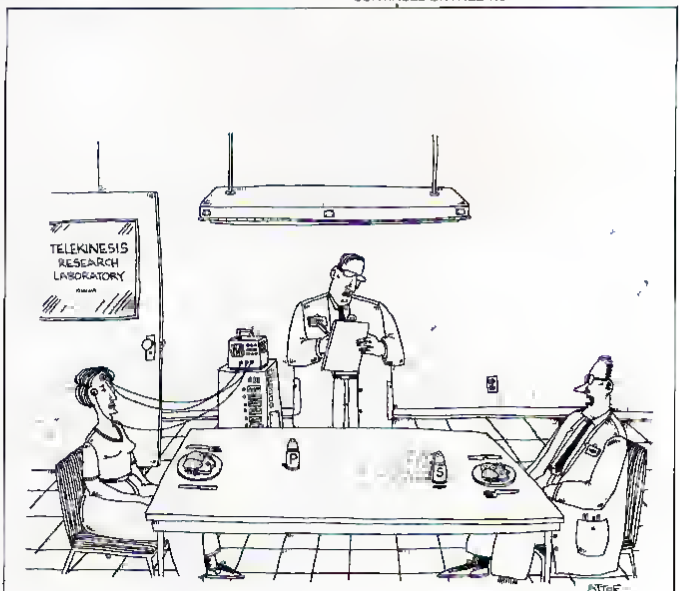
Follini: [rubs her arms, sighs, seems to be anxious about the question] During the last week I was very tired. I experienced various emotions simultaneously. Toward the end of the week, I only thought: *Let me go in.* I nearly entered at a run. I wished to close out everything.

Omni: When they sealed the cave the first day and shut out the sunlight, how did you feel?

Follini: Possible answers: "Ah, they are not kidding." "Finally alone." And now what?" [These are the exact responses she typed out on her screen.]

My first reaction was relief. Then it took some time before I realized where I was—yes, it's really true. I am here. But I felt a certain dismay at my new surroundings, even though I imagined it thousands of times. I thought, "I am involved"—*sia mo in ballo*—"in the middle of the dance." Now let's see how I will manage. Now it seems

CONTINUED ON PAGE 110



"I'm still not convinced. I wanted the pepper."

PICTORIAL

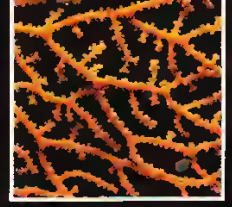
An underwater lens exposes the diversity of color and texture found in the architecture of the reef

A WORLD OF CORAL HARMONIES

PHOTOGRAPHS BY JEFF ROTMAN

Viewed from an airplane, a coral reef swirls patterns into the sea below, etching brown into vibrant blue. Seen from the water's surface, the same coral stands stolidly, arching up to the sky like a sheath of trees. And to the underwater eye, a coral reef is a submerged city, home to a plethora of undersea life. But to appreciate the unmitigated beauty of coral, it is necessary to take a closer view and gaze at the varied colors and designs that compose the reef. Photographer Jeffrey Rotman has been doing precisely that for the past eight years. Rotman uses a series of macrolenses and special lighting effects to depict individual coral polyps. The underwater specialist has captured images that even a skilled underwater diver would never glimpse.

Close-np encounters: coral potterns dispiny o dizzying diversity of colors ond textures.



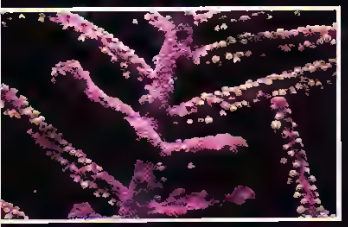
Previous poges: Coils of sheet coral (left); white polyps ndorn tips of n scnrlet sea fan. These

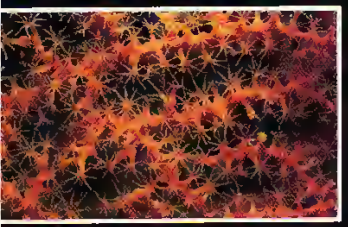
poges, left to right: Mushroom coral's intricntely designnd shell; hnrd cornl fannd in the Rnd Soo;

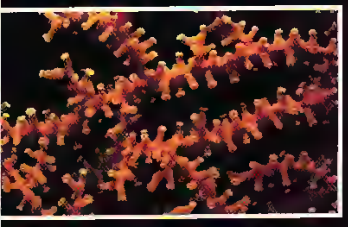
costin cnral crnntes n mnzn pnttern; pnin tips of stnghorn cnral finished with bright magenta;

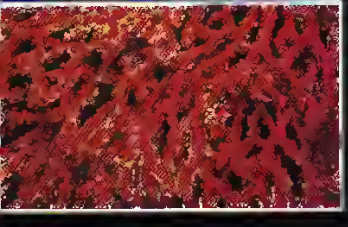
yellow polyps grace the onter edge of n cornl; n sen fan cnral nntivn to the Cayman Islands.

Belnw: Not white or gray but yellow matter—close-np of o brain coral from the Bahamas.









Whee coral ventures from its shelter, the polyps treesform the reef world into e shimmering wonderland. Left-hoed colume, from top to bottom: A purple sea whip; twe close-ups ef Red Sea orange corel; twe photographs of gorgeeice coral polyps, eee from the Red See, the other from Jepenese weters. Right: A mass of Red Seo coral polyps, generally known, not surprisiegly, as bubble coral.

A diver would have to press his nose to the coral and then view the specimen through a magnifying glass to see what Rotman's camera sees.

"You won't find the colors and textures of corals anywhere on land," says Rotman. "There is some real beauty here."

But the beauty of coral goes beyond aesthetics. Closely related to the jellyfish, coral provides the foundation on which reef ecology rests. In Australia's Great Barrier Reef alone, more than 3,000 species depend on tha coral for survival.

Nicknamed the flower animal, coral is not a plant, as is commonly thought, but an animal. The animal lives inside a limestone shell, which it secretes around itself. The polyps come out only to teed.

A coral reef forms when parent polyps release hundreds of larvae into the sea. Some are lost, but others settle successfully. Coral reefs grow via asexual reproduction, when a parent polyp releases offspring in a process called budding.

"The structure of nature is there—the design of nature, the essence of nature," Rotman says. "These little individual simple animals really sparkle."

—Shari Rudavsky

EARTH

CONTINUED FROM PAGE 26

the southern elephant seal relentlessly hunted in Antarctic waters for its blubber, had been rendered nearly extinct by 1885. By the same year the northern elephant seal, the southern seal's smaller cousin, was thought to be extinct indeed.

But if the sea mammals are harbingers of wider troubles in the ocean, they also represent our first victories against those troubles. With protection and reintroduction, sea otters have established themselves again on long stretches of the California and Alaska coasts. The blue whale has been protected since 1948, and its populations are recovering. The gray whale has rebounded with protection from a low of around 1,000 animals to today's 21,000. The southern elephant seal, protected since the 1960's, now numbers nearly a million. The northern elephant seal has multiplied from several dozen to today's 80,000 to 90,000.

One of the great accomplishments of recent years, the Marine Mammal Protection Act (MMPA) of 1972, is already in need of rescue. The MMPA was a response, in large part, to the problem of "incidental" dolphin kills by the tuna industry. For reasons unknown, Pacific yellowfin tuna swim in close association with schools of spotted and spinner dolphins. In the old days, tuna fishing was by rod, baitless hook, and line. The accompanying dolphins, too smart to go for baitless hooks, were not inconvenienced. All this changed in 1960, with the application of purse-seining techniques to tuna fishing. Since then, any dolphins sighted in the eastern tropical Pacific are surrounded by a huge seine. Cables draw the purse in the seine tight, trapping the dolphins and any tuna swimming underneath. The Sixties were catastrophic for the dolphins of the eastern tropical Pacific. Some escaped the nets, but many drowned in the net or tore themselves apart against the mesh. By 1972 and the passage of the MMPA, 500,000 dolphins were dying each year, and stocks of certain species had been reduced by 80 percent. Since 1960, according to government reports, 6 million dolphins have been killed by the purse seiners.

After passage of the MMPA, tuna fishermen worked with scientists to design improvements like the Medina panel, with a finer mesh that prevents dolphins' beaks and fins from snagging. They refined the "back down" procedures by which dolphins are released before the nets are hauled aboard. According to the provisions of the MMPA, the dolphin kill was to be reduced each year until it reached "insignificant levels." Through the Seventies it did so. In 1981, 1982, and 1983 the quota remained the same (20,500). In 1984 the MMPA was amended under tuna-industry pressure to permit that quota to be extended indefinitely. Research on dolphin-saving gear and techniques has halted. The National Marine Fisheries Service has done little about cheating and has failed to make findings against the countries whose tuna fleets are killing dolphins in excess of the law.

Another proud feat of marine environmentalism, the 1985 moratorium on commercial whaling, is being compromised. Whaling interests, like the tuna industry, have never ceased nosing about for loopholes. Some years after the International Whaling Commission (IWC) gave complete protection to blue whales, Japanese scientists discovered the 'pygmy blue,' a new species exempt from the ban. The Japanese began "scientific" whaling. On their January 1988 expedition to Antarctica, Japanese whaleships engaged in the scholarly slaughter of 273 minke whales. Japan's government told the IWC's Scientific Committee that it did not feel obligated to submit data on these research kills because they were not "catches," they were 'samples.'

The obdurate whaling nations of the West were quick to turn their own whaleships into "research vessels." Iceland killed 76 fin whales and 40 sei whales in the summer of 1987. Norway plans to kill 30 minke whales in the North Atlantic. This is the thinnest sort of subterfuge. The Reagan administration allowed it to happen, even abetted it. If there is an answer for it, under the Bush administration it is strong sanctions.

In a catalog of ills like this one, it is easy to lose sight of the fecundity, beauty, and mystery that reside still in the seas. The ocean remains what Hemingway called it a half century ago, "the last wild country we have." I spent six months of my life with two photographer friends in a small boat on the deep ocean off Kona, Hawaii. We documented whatever came our way. We dove with pilot, humpback, and sperm whales. We jumped in the water almost daily with spotted dolphins. We swam in the wild with rough-tooth dolphins, a species so rare that the first living specimen was not discovered in the North Pacific until the 1960's. We swam with the melon-headed whale and with Blainville's beaked whale, which has a smallish, dolphinlike head attached to the body of a whale. The bull is armed like a boar, with a pair of stout tusks at the midpoints of the jaw. Until I met Blainville's whale face-to-face, I had no idea that such an animal existed.

I, for one, find it cheering that the universe of Blainville's whale will survive us. The ocean has had lean times before, as after the planet's epochal collisions with asteroids and comets. Our worst thermonuclear error will not end life in the deep, and species will radiate again. I am happy to have known firsthand the once and future ocean. ☐☐

This is the third in a three-part series.

FORUM

CONTINUED FROM PAGE 18

became aware of the program through a newspaper article and was appalled by the school's lack of textbooks and facilities. The school operates on a budget of about four dollars per student, which is insufficient to provide textbooks in every subject for every child. A science laboratory remains a fantasy.

While community involvement is less than a year old, Foster started her alternative program in the Garnet school four years ago. She had a reputation for success working with hard-to-handle students. In 1984 she was given 60 kids from other schools who were perceived as high-strung and with little regard for discipline. Each year more and more parents who wanted extra help for their kids asked Foster to take them in. Soon she had a couple hundred students. "Regular education is not just meeting the needs," says Foster. "The whole child is my motto, and that means we take on the social problems as well as the reading and writing challenges."

For some who work with Foster now, that strategy has broadened their roles. "Sometimes we have to teach them how to eat, walk, and work out their anger before we can teach them to read or do math," says McArthur. "They're brutal with each other, and it's a way of life. I don't understand how we're going to get that out of them, especially since it gets reinforced on the TV and in the streets."

The kids claim to take their studies seriously. Says one boy whose attendance record is blotchy: "My mother teaches me to be obedient—be all you can be, get as much education 'cause it's a dangerous world out there." In the school's fenced-in playground, the kids constantly chatter about "making a lot of money and getting out of here." They speak of becoming computer operators, lawyers, doctors, and architects. When asked what they worry about, they tick off nuclear war, the Middle East, the homeless, the atmosphere, and getting their mothers out of New York.

Not long ago, as Foster, her staff, the adopt-a-class sponsors, parents, and classmates looked on, the middle schoolers paraded through their assembly room clad in traditional African garb, their heads held high. After four months of preparation, the African–American Heritage pageant was at last under way. "Strong man keep movin' on. Strong man git stronger . . ." they chanted. Sterling Brown's *Strong Man* provided a powerful message, and their gusto seemed unbridled: their performance a testament to their talent and their ache to succeed. "I want these kids to be good citizens, good husbands, good wives, good parents—good people," declares Foster. "I know they can be that." ☐☐

ARTICLE

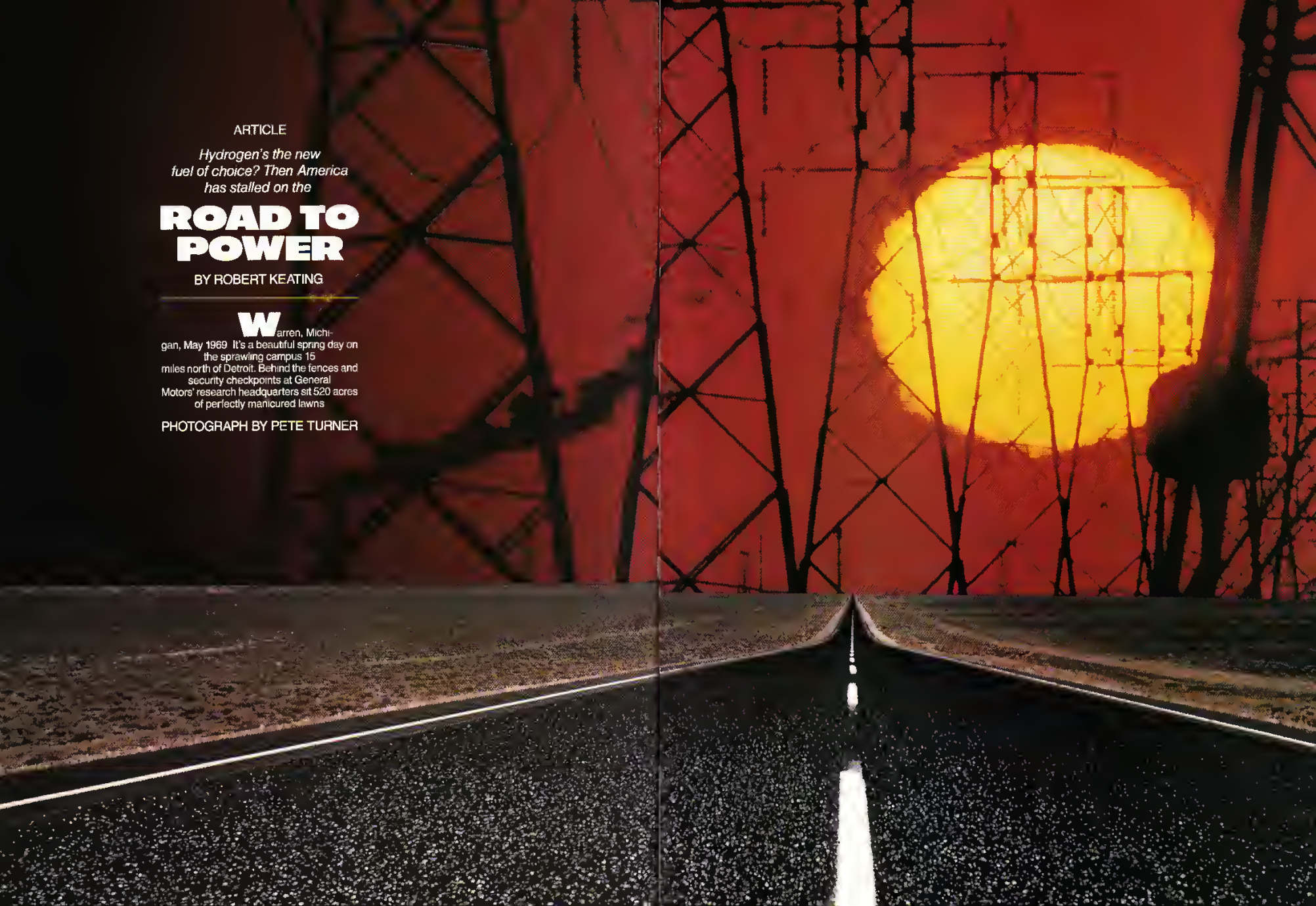
Hydrogen's the new fuel of choice? Then America has stalled on the

ROAD TO POWER

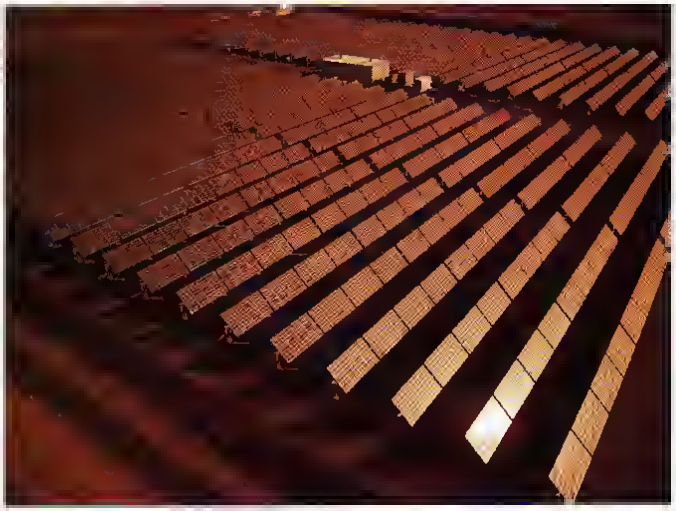
BY ROBERT KEATING

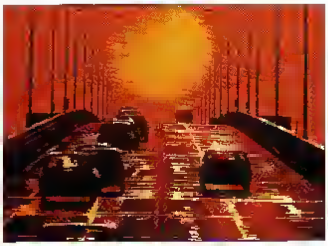
Warren, Michigan, May 1969 It's a beautiful spring day on the sprawling campus 15 miles north of Detroit. Behind the fences and security checkpoints at General Motors' research headquarters sit 520 acres of perfectly manicured lawns

PHOTOGRAPH BY PETE TURNER



"He envisions the earth's deserts canvased by vast stretches of solar farms, spread out in geometric clusters to harvest the sun's light."





and gardens. The grounds are traversed by smooth, paved roadways and spotted by many neat two- and three-story brick buildings. Geese, ducks, and swans are returning to the many streams and ponds, some as large as 18 and 22 acres each. Deer roam beneath the blossoming trees. The setting is idyllic. But in the conference room where electrochemist John Bockris is holding court, things are far from ideal. If the world's supply of oil dwindles, the automobile industry will need an alternative to gasoline. Betting on that alarming fact, Bockris has been called in by GM to consult on what the company hopes will be an alternative—the electric battery. But as the day's session draws to a close, the battery's lofty position in the future is unexpectedly replaced. "We created six scenarios," Bockris recalls. "And four of the scenarios ended up with hydrogen at the bottom line. I said, 'Hmm, we'll be living in a hydrogen society.' Someone else added, 'It'll be sort of like a hydrogen economy.' " That was the origin of Bockris's vision.

For two decades Bockris has chased his dream of a hydrogen society—a world fueled by this clean and abundant element. Today the distinguished professor

of chemistry at Texas A&M, the small, energetic man who popularized the phrase *hydrogen economy* in 1969, envisions the earth's deserts canvased by vast stretches of solar farms—spread out in geometric clusters to harvest the sun's light with their photovoltaic cells. An electric current will then electrolyze pools of water, protected from evaporation, into its primary elements—hydrogen and oxygen. After these gases are captured and stored, they are piped to urban areas in less sun-drenched countries whose economies they fuel. Even though hydrogen is the most plentiful and lightest element in the universe—the first on the periodic table—it barely exists as a free element on Earth's surface because it rises in the atmosphere and is released in space. On Earth, the invisible, odorless gas has combined with other elements.

Hydrogen can be extracted a myriad of ways. For example, it is usually obtained by separating it from natural gas through a process called steam reforming. Hydrogen is also extracted from water through photolysis, a chemical reaction that uses sunlight, or through electrolysis of water, the second most common technique. By passing electricity through water from one electrode to another, the liquid is split into two parts hydrogen, one part oxygen. Commercial hydrogen is most widely used in the manufacture of ammonia—15 million tons per year, accounting for two thirds of the world's hydrogen consumption. Oil refineries use one fifth of the world's hydrogen to process petroleum products. Other uses: to produce fertilizer, dyes, and the most powerful of rocket fuels.

If Bockris has his way, we will live in a solar–hydrogen age in which nonpolluting hydrogen fuel would replace petroleum fuels. The fossil fuels that propelled the world through the industrial age are now killing it. Half of the carbon dioxide emissions in the United States come from oil. Coal and natural gas make up the rest. Carbon dioxide levels have increased 25 percent since 1958—with 5 billion tons of carbon released into the atmosphere each year from the burning of fossil fuels. There the carbon dioxide joins chlorofluorocarbons and other gases to create the dangerous greenhouse effect, trapping radiant heat and causing global warming. Sulfur and nitrogen oxides spew

Clockwise from top left: Solar panels spread out to receive the sun's light; pollution from commuter traffic greets the setting sun; two ways to produce energy—an oil refinery and an electric plant.

from power plants and cars producing the acid rain that is destroying our lakes and trees. Ground-level concentrations of ozone the principal component of urban smog and a by-product of fossil fuel burning have doubled in the earth's atmosphere in the last century (In the stratosphere, ozone is beneficial forming a protective shield against ultraviolet radiation.) Unfortunately fossil fuels provide 80 percent of the world's energy needs and no practical alternative is near.

A May 1988 Canadian conference on world climate change resolved that all governments must cut carbon dioxide emissions 20 percent by the year 2005 and 50 percent by 2050. Jim MacKenzie senior associate at the World Resources Institute in Washington, DC, puts the figure at 50 to 80 percent. "The kind of technology that Bockris talks about would have an impact on our oil dependency air pollution, and the greenhouse effect and would go a long way toward solving these problems," says MacKenzie.

The fuels we use today however, are not just polluting the environment. The renewables—wind sun, or hydropower—are unreliable because wind stops the sun goes down, and water dries up. As a fuel nuclear power is the most efficient costing $ 71 per million BTUs: coal costs $1.58 and oil $3.04 to produce the same amount. But the impact of strict federal regulations coupled with the high cost of operation and maintenance has made nuclear a very expensive way to produce energy. Nuclear is more costly than its competitors, though the figure varies from utility to utility. The introduction of hydrogen as a storage medium and secondary fuel source would enable utility companies to take advantage of off-peak usage, store the energy, and then move it to where it's needed, making hydrogen a perfect complement to nuclear.

Safer, less expensive nuclear energy however is a distant hope at best. Hydrogen fusion, for example, has had a lot of recent exposure because of the extraordinary claims of a pair of researchers at the University of Utah. (In nuclear fusion the nuclei of hydrogen atoms are joined to produce helium and large amounts of energy. In fission, the process used in today's nuclear power plants, atoms are split to produce energy.) The scientists claim they have created a sustained nuclear reaction—at room temperature—in a wire made of palladium, a metal often used to stimulate a chemical reaction.

Martin Fleischmann, professor of electrochemistry at the University of Southampton, England, and B. Stanley Pons, chairman of the department of chemistry at the University of Utah, collaborated on the very simple experiment. They immersed two electrodes in a container of heavy water, or deuterium oxide, which is easily extracted from the ocean, and passed an electrical current between the electrodes. The electrical current split the molecules of heavy water, and the positively charged deuterium atoms separated from the water molecules were drawn to a negatively charged cathode made of fine palladium wire. This was the site of the sustained fusion reaction. The researchers claim that the device produced four watts of energy for every watt used. "We hope we'll be able to work with others to develop this into a usable technology for generating heat and power for the world," says Fleischmann. "The process is clean, and indications are it will be economical compared with conventional nuclear systems."

Most fusion experts, however, fear it will be years before commercial applications are available. But Bockris hopes Fleischmann and Pons are right about the discovery and the cost. "If they have sustained a fusion reaction, it's wonderful," Bockris says. "We would then go ahead with our plans for hydrogen using fusion instead of using solar to electrolyze water."

T. Nejat Veziroglu, director of the University of Miami's Clean Energy Research Institute and president of the International Association for Hydrogen Energy, says that the discovery by Pons and Fleischmann could be one of the most important discoveries of the twentieth century. According to Veziroglu, during the production of deuterium fuel, hydrogen would be produced as a by-product, making it economically competitive with petroleum. The relatively clean fusion energy would produce cheap, abundant electricity and speed up the introduction of a hydrogen economy.

For more than two decades Bockris has been a leader of a small group of scientists—about 3,000 worldwide—who hope to usher in the age of hydrogen. At the University of Madras in India, for example, P. Maruthamuthu is producing hydrogen from oxalic acid laced with a copper–tungsten oxide catalyst. Instead of using electricity, Maruthamuthu exposes the solution to direct sunlight, which interacts with the catalyst to separate out hydrogen. (Oxalic acid is used for bleaching and is a common laboratory medium for chemical reactions. Tungsten is a resilient metal used in high-speed drills and in the space program; tungsten oxides are reducing agents used in chemical reactions like Maruthamuthu's.)

In Japan researchers working at the University of Osaka Prefecture are fine-tuning supersonic aircraft engines fueled by liquid hydrogen. At Texas A&M's Center for Electrochemical Systems and Hydrogen Research, director John Appleby, who cofounded the center with Bockris in 1987, is making advances with a highly efficient fuel cell that will convert hydrogen into electricity. One of his graduate students concentrates on obtaining hydrogen from biomass—plants and waste materials. All work toward the

"Things don't always work the way they're supposed to. Since I subscribed to The New York Times, people find me less interesting."

same goal: a clean, abundant, versatile energy source. Despite their lofty goals, some in the scientific community view the work of hydrogen researchers as folly, even referring to them as the Hydrogen Mafia. "Real men drill for oil," says one scientist, laughing.

Unfortunately, history has tied hydrogen to a disaster in which it actually played little part. Maneuvering through a bad thunderstorm on an overcast day in 1937, the dirigible *Hindenburg* caught fire as it approached a docking station in Lakehurst, New Jersey. Thirty-six passengers and 22 crewmen died—most leaping from the craft. What is forgotten is that 65 people walked away after the gondola reached the ground. Because hydrogen is light, flames rise rapidly in combustion, producing little heat or damage. If escape measures had been planned in advance, hydrogen would not have been implicated in the disaster.

Testament to the power of hydrogen as a rocket fuel are the billions of dollars several nations are spending on hydrogen-fueled aerospaceplanes. The U.S. National Aerospace Plane is being developed under a shroud of secrecy at Wright-Patterson Air Force Base in Ohio. The size of a 727, it will fly 20 miles above the earth at speeds that may reach Mach 25. In Europe, the proposed aerospace projects Hermes and HOTOL will also be hydrogen fueled. Still on the drawing boards, Hermes is a French venture similar to the U.S. shuttle and HOTOL is a British version of the aerospaceplane. Japan's hypersonic commercial passenger plane, with a cruising speed of Mach 5, will also be fueled by hydrogen.

If hydrogen is one of the highest-quality fuels available, if it's safe and clean, as scientists like Bockris claim, why hasn't there been a concerted effort to develop it? The problem, contend hydrogen opponents, is the prohibitive cost of producing hydrogen as a fuel. "I think a hydrogen economy is unlikely," says Mark Mills, president of Science Concepts Inc., a Washington, DC, energy consulting firm. "It's not going to compete with existing energy programs, not unless it's half the price of what already exists." Carl Goldstein, a vice president of the U.S. Council for Energy Awareness (USCEA), concurs. "It's not a perfect fuel. It has hazards such as high combustibility, but the main drawback is the cost of producing it. There must be a reason why there's been no breakthrough in the past thirty years," he continues. "It will take a lot of work to get to a hydrogen economy."

Even so, a growing number of authorities in the scientific and environmental communities say that when you take into account the cost of pollution from fossil fuels, which Appleby estimates at about $1 per gallon of gasoline, hydrogen may prove economically competitive. "This figure puts a hidden tax on the gross national product somewhere on the order of thirteen percent," says Appleby.

Two years ago, Bockris joined 64 other scientists worldwide in signing a petition that Veziroglu had drafted calling for environmental surcharges on products that damage the environment. Veziroglu is considered one of the most knowledgeable researchers in the hydrogen field. In 1984 he published a report estimating both the environmental and health costs due to the burning of fossil fuels. Twenty-five billion tons of carbon dioxide, carbon, sulfur dioxide, nitrogen oxide, ozone, soot, and ash poisoned the atmosphere that year alone—and the pollution increases every year. According to Veziroglu, in the United States alone fossil-fuel-related deaths—including heart disease, chronic and acute respiratory illnesses, cancer, and lead poisoning—cost $133.8 billion annually.

Each year environmental costs in the United States range from $4.4 billion spent on land reclamation necessitated by strip mining to $73 billion in damage caused by leakage from underground gas tanks. Another $8.2 billion is lost in farm produce due to ozone and acid rain. "The environment subsidizes the existing fuel mix," says Rafe Pomerance, senior associate for policy affairs at the World Resources Institute. "Not internalizing the price of the climate-change risks and other environmental costs of fossil fuel delays the onset of alternatives."

"Some in the scientific community view the work of hydrogen researchers as folly, even referring to them as the Hydrogen Mafia. "Real men drill for oil," says one scientist, laughing."

Today Bockris is working to keep his dream alive. "We think the world—at least the United States or West Germany, to begin with—will be a wonderful place," he says. "My vision is held back only by the political climate of the moment."

Last summer, even as Congress held hearings on the greenhouse effect, the Department of Energy (DOE) was cutting funds for most energy programs. Part of the legacy of the Reagan era is that the burden of preparing for the nation's long-term energy needs has been shifted to the private sector, which is driven entirely by short-term profits. "The DOE seems so biased and fixed in an antihydrogen direction," Bockris says. "I've been in DOE offices where if you talk about hydrogen they think there's something sacrilegious about it. They even speak about it in lowered voices. Economically, they're not taking a long-term view."

Hydrogen research in the United States is largely limited to four academic centers: the University of Miami, the Florida Solar Center, Texas A&M, and the University of Hawaii. Meanwhile, funds for hydrogen energy programs at Brookhaven National Laboratory on Long Island, New York, have been cut by the DOE from the 1978 high of $6.5 million to last year's $600,000—and at the end of this fiscal year the DOE is shutting down the program completely, shifting Brookhaven's responsibility to the Solar Energy Research Institute in Boulder, Colorado. Today, according to Bockris, fewer than 40 people do full-time hydrogen research in the United States. And outside of military expenditure, only $3 million of federal money goes into hydrogen energy research in this country. In fact, says Jim Wegrzyn, senior physicist at Brookhaven, "very little of DOE's budget is being spent on hydrogen. We need a coherent policy for hydrogen production." According to Bockris, the United States is relatively unprepared for the future. "In the race to produce hydrogen," he says, "we're running behind the Soviet Union, Canada, and West Germany."

The Soviet Union, for example, has had a history of success with hydrogen. In 1942, during the siege of Leningrad, fuel for vehicles ran out, so automobiles and trucks were modified to run on the hydrogen stored for use in floating the city's many antiaircraft defense balloons. In the early Sixties the Soviets shifted to hydrogen as the main fuel in their space program. At the seventh annual hydrogen energy council held last September in Moscow, the Soviets renewed their commitment to hydrogen research. Months earlier a scientist reported, one of three engines on a Soviet Tu-155 commercial jet had been fueled entirely by hydrogen during a 21-minute flight. And in Siberia preparations are under way to drill for what are hoped to be underground streams of hydrogen.

Canada's spirited pursuit of a hydrogen society is captured in a government-commissioned report entitled *Hydrogen—National Mission for Canada*. With large reserves of natural gas, the fossil-rich Alberta Oil Sands, and the giant hydroelectric facilities in St. James Bay, Canada is certainly ready to produce hydrogen in the near future. The Hydrogen Industry Council (HIC), an organization of about 50 corporations including Esso Petroleum and Atomic Energy of Canada Ltd., is considering the possibility of switching the national rail system from diesel fuel to liquid hydrogen. Also under consideration: exporting cheap electricity in the form of hydrogen to Europe.

West Germans, angered because acid

rain caused by fossil fuels is destroying their forests, are searching for alternative energy forms. Incensed and shaken by the potential aftermath of the 1986 Chernobyl accident, the West German government has created a $100 million annual budget for hydrogen research, with another $100 million being spent by the private sector. Daimler-Benz, for instance, the parent company of Mercedes, is testing hydrogen-fueled cars. Three German corporations are putting a super-quiet, hydrogen-powered submarine through tests at sea. West Germany's aerospace agency has contracted with Saudi Arabia to build a 350-kilowatt solar–hydrogen facility near the sun-drenched town of Riyadh. And a $27 million, 500-kilowatt solar–hydrogen facility is planned for Bavaria.

Although the United States has balked at throwing its weight behind hydrogen research and development, Bockris is tireless in his commitment to his hydrogen dream, traveling the globe to attend conferences, visiting universities, speaking to anyone who will listen.

Last December, Bockris followed the route of one of his imaginary pipelines that he hopes someday will carry hydrogen from Texas to New Jersey. There he visited Joan Ogden and Robert Williams, researchers at the Center for Energy and Environmental Studies at Princeton University who are studying the possibilities of using amorphous silicon photovoltaics to produce hydrogen.

In the past, solar cells could be made commercially only through a costly crystal-growing process. And while the cells' 31 percent efficiency is better than that of fossil fuels, the cost of manufacture has made their use in a solar–hydrogen system prohibitive. Williams and Ogden, however, are structuring their work around significantly cheaper amorphous silicon cells. (Amorphous silicon solar cells, like those on the faces of tiny electronic calculators, generate power from indirect light. Today these cells also charge batteries that power everything from cars to boats to electric fences.)

Where would Williams and Ogden begin to apply their research? Phoenix, Arizona—hypothetically, that is. In 1987 Phoenix violated federal air-quality standards for ozone, carbon monoxide, and particulates 33 times, Williams says. "At first, hydrogen produced from existing electrical power plants during off-peak hours could run a fleet of 30,000 vehicles with photovoltaic [PV] cells, eventually supplying the energy for hydrogen production. In 25 years half of the cars in Phoenix could be fueled by a 20- to 30-square-mile field of PV cells, depending on their efficiency."

Then Ogden and Williams argue, the solar farms could be expanded to other parts of the country via pipeline. In the Northeast, heating systems in older homes could be retrofitted to accommodate hydrogen, or the fuel could be mixed with natural gas as an extender. Newer homes would be heated entirely by hydrogen. And eventually, instead of stopping at gas stations, people could refuel their cars at home from small compressors installed in their garages.

"You have to be very careful," Williams warns. "As far as economics is concerned, it's going to be a wash between hydrogen and all the synfuels [synthetic or liquid fuels made from domestic coal or oil shale]. But as far as usefulness and the future of the environment is concerned, hydrogen's a clear winner."

Bockris has never been more encouraged. "Their work is really the best justification I could wish for as proof of the ideas that I've had since 1975," he says. In his world of tomorrow he sees the once dangerously polluted cities of Europe and the United States powered entirely by hydrogen. Acid rain has disappeared. The skies have cleared. Global warming has eased, and the air-pollution problem has long since been solved. Developing countries are also benefiting from a world that has "gone hydrogen." Burned as a gas, hydrogen heats homes and cools appliances. And in a world that has become increasingly electric, hydrogen is pumped into highly efficient electrochemical fuel cells, which convert it to cheap and steady current. This simple element fuels everything from lightweight, nonpolluting automobiles to the aerospaceplanes that shuttle between New York and Tokyo or Moscow in two hours time. And the only by-product of hydrogen's powerful combustion is a clean, harmless water vapor, produced as it rejoins the oxygen in the air. The vapor is so clean, in fact, that many regions convert it to drinking water.

With the planet running entirely on a hydrogen economy, the world's wealth has shifted. Ethiopia, Saudi Arabia, India, the Sudan—countries that invested in solar energy—are the rich nations. Forward-looking countries like Canada and West Germany profit by exporting their advanced hydrogen technology. And the United States, which for so long lagged behind in developing a solar–hydrogen system, has struggled back, deploying its first solar-paneled space platform.

The stuff of fantasy, some researchers would say. But in 1874 an engineer, shipwrecked with several other people in Jules Verne's *Mysterious Island*, was asked what man would use for fuel when the earth's coal finally ran out. "Water," the engineer responded. "Yes, my friends, I believe that water will one day be employed as fuel, that hydrogen and oxygen, which constitute it, used singly or together, will furnish an inexhaustible source of heat and light." In 1974, 100 years after Verne's prophecy, with the completion of *Energy: The Solar Hydrogen Alternative*, Bockris may well have designed the perfect energy system. ☒

INTELLIGENCE

CONTINUED FROM PAGE 26

an innovative oil lamp by the Greek inventor Philon in about 300 B.C. Philon's original goal was to create a lamp that would burn much longer than conventional lamps without refueling. So Williams broke down the components of Philon's lamp design into a series of equations. These components included a lamp with a small fuel chamber at its base, a larger, spherical fuel reservoir, a jar of oil, and an array of small pipes and valves. Among the properties also meriting an equation were the force of gravity on the lamp and its fuel, the behavior of the oil in a closed system, and the way the oil, the chambers, and the valves worked together to fuel the lamp.

A key modification that Williams formulated into a numerical equation involved a valve that lay between the large fuel chamber and the smaller chamber at the base of the lamp. Philon had designed the valve so that when there was plenty of oil in the lower chamber, the pressure of the liquid against the valve kept it closed. When the oil level dropped, the valve opened, and more oil flowed into the smaller chamber.

When Williams ran his Q1 math on this design, the computer verified that Philon's original blueprint would work. Q1 had mathematically reworked the thought processes of Philon's mind and arrived at the same conclusion. Williams's next step is to see if Q1 can actually replace Philon. His plan is to set up the equations so that the computer can look at the components and principles of the oil lamp before Philon applied his creative genius to bettering it. Then if Q1 is as powerful as Williams thinks it should be, able to actually "reinvent" certain innovative components of Philon's lamp.

The long-term goal, of course, is a computer that can use basic principles to arrive at a wide variety of novel designs. Williams admits that talk of an "automated engineer" makes its human counterparts nervous. But he insists that "we don't really want to yank the designer's job away from him." A computerized "apprentice system"—a designer's little helper—could become a sort of para-expert able to advise the engineer on specific areas and thereby allow him to concentrate on the big picture.

Perhaps the most intriguing aspect of Williams's computer machinations is their potential for enlightening us about the human mind and its capacity for endless invention. "First and foremost," he says, "human beings are tool builders—we meet new challenges in the environment by thinking up new instruments to deal with them. That's the process we want to comprehend. It will take at least fifty years until the computer actually becomes an inventor," he continues. "But Q1 will be the first step." ☒

"My goal is not to 'be with' dolphins in the open ocean as we encounter some adventure," says the world's leading cetacean-intelligence investigator. "I'm interested in communicating more effectively with dolphins and learning how they communicate."

INTERVIEW

LOUIS HERMAN

Tankside at the University of Hawaii's Kewalo Basin Marine Mammal Laboratory, director Louis Herman is pirouetting in front of a pool. The dolphin Phoenix spots him and spins in turn—a man-to-sea-mammal game of Simon says. Two dogs, part of the facility's ever-growing menagerie, follow Herman up the steps of a 12-foot-high redwood observation tower equipped with computer terminals, a Yamaha DX7 synthesizer, and a sound system connected to underwater microphones. Diamond Head Crater, an extinct volcano, looms against the Pacific to the east, where parasailors float off Waikiki. Below in two 50-foot-wide pools, four dolphins work and play. Their porcelain-like figures burst from the water in jumps so exultant as to proclaim that every part of their being, from their sleek gray backs to their pearly-white undersides, is experiencing sensations more exquisite than we can imagine. Watching, it's easy for us to anthropomorphize. Their anatomy evolved so that they seem to be perpetually

PHOTOGRAPHS BY ALAN D. LEVENSON

"A dolphin might think we don't demonstrate swimming until we can leap fifteen feet from the water, stay under for fifteen minutes, or swim at twenty knots. Otherwise, we humans shouldn't really be calling it swimming."

smiling, as if they've found some higher knowledge—the key to happiness.

How much do they really know? Over the years scientists have argued that linguistic communication and comprehension is the sole hallmark of thought and a uniquely human characteristic. After successfully teaching a complex vocabulary to two 12-year-old female Atlantic bottle-nosed dolphins, Herman has proved for the first time that dolphins understand not only language but grammar and syntax as well. Beginning in 1979, Phoenix and Akeakamai were each taught an artificial language. Phoenix's consisted of electronically generated computer whistles; Ake's was based on arm gestures. The languages have their own rules for syntactic word order, and with these words thousands of sentences—of up to five words—as well as two-word questions can be constructed.

Herman is no modern-day Dr. Dolittle. His goal is not to "talk" to dolphins but to examine ways to communicate with them more effectively and to understand better the scope of their intellectual skills. His colleagues speak of him with reverence, as much of a friend and teacher as he is a scholar of cetacean intelligence. A dolphin fanatic myself, I've followed his work for years, and it's clear from my visits to his lab (once as a querying student) that he is as cautious with words as he is disciplined with research. The author of one book and more than 100 papers on dolphins and whales, he refuses to speculate on the limits of cetacean mental function. "What is revealed almost always turns out to be more interesting than the mundane fantasies people maintain about dolphins," he says from an office decked with the sweeping plate (feeding bristles) from the mouth of a baleen whale, photos of lab residents—human and animal—and scripts from Peter Benchley's TV series *Dolphin Cove*, for which he is the consulting scientist.

Herman lives on a ridge at the eastern end of Oahu with his wife and nine-year-old daughter, whose soccer team he avidly coaches. A suntanned, bearded man with a head of salt-and-pepper curls, he was born and raised in the borough of Queens, New York. His love for the ocean and its inhabitants was nurtured by summers at the shore and as a lifeguard at Rockaway Beach. A powerful swimmer, he briefly held the Hawaii state record in the 50-meter freestyle for men over forty. After receiving B.A. and M.A. degrees in psychology from the City University of New York, Herman did a brief stint as an Air Force intelligence officer before concluding his doctoral work at Emory and Pennsylvania State universities.

In a library at Penn State, Herman happened upon a book by British psychologist Donald Broadbent that shaped the course of his career. *Perception and Communication*, written in 1958, became his bible and the stimulus for his doctoral dissertation on how efficiently humans handle simultaneous tasks. One of the earliest attempts to use the concepts of information processing to understand the human ability to handle multiple demands, the thesis won the American Institute for Research's Creative Talent Award. This honor persuaded Herman to leave an Ohio job on decision making in antisubmarine warfare systems—determining and classifying targets received by sonar to make them more reliable—and return to academe to begin the dolphin work for which he is best known. "To this day," he says, "as I see dolphins as active processors of information, these are concepts Broadbent advanced."

In 1966 Herman began work as an experimental psychologist at the University of Hawaii. The next summer, recognizing there was little objective information on the learning abilities of dolphins, he "borrowed" a dolphin and tank from a nearby oceanarium and organized a graduate seminar to study the development of learning skills in the dolphin. A year later, when a permanent facility was in place, the Navy gave Herman the dolphin Kea, then Puka. And after receiving a five-year research grant from the National Science Foundation, he began studies on dolphins' visual and auditory abilities, memory and learning skills.

In 1976, the same year Herman began field studies on the behaviors and social organization of humpback whales, he also began studying dolphins' ability to understand artificial languages. Using the dolphin Kea, he set up a sonic language consisting of a small vocabulary with a miniature grammar. The work was progressing quickly. But just as rapidly it stopped. Already soft-spoken, Herman's throat seems to tighten as he speaks of the 1977 night when two disgruntled ex-employees who had recently been discharged from the lab packed Puka and Kea into a van, transported them almost 50 miles, and released them into Oahu's Yokohama Bay. Unfamiliar with Pacific waters and hand-fed most of their lives, Puka and Kea disappeared, most likely they met with violent deaths.

The tragedy undoubtedly marked Herman for life. As I sit facing him, listening to the dolphins splashing playfully in the brilliant orange dusk outside his office, the pain in his voice makes me want to dive into the ocean and search every inch of it until I find them. But it is also clear to me that Herman and his colleagues have moved zealously forward.

Almost a year and a half after the theft, two new dolphins arrived. Herman named them Akeakamai, which means "lover of wisdom," and Phoenix, whose name was chosen to represent the rebirth of the lab.

In the last decade, scientists have come to regard Herman's work with these dolphins as the most advanced in the field of animal-language research. He has also begun teaching two four-year-olds—

Haipo a male and Elele a female—a language that may enable them to communicate with each other. And in what may be his most ambitious avenue of research, he is trying to decipher their natural vocalizations —Justine Kaplan

Omni: Obviously you're best known in the scientific community for your dolphin research. But you captured public attention with the rescue of the humpback whale Humphrey in the fall of 1985. What happened then?

Herman: Humphrey had turned into San Francisco Bay and begun to swim up the Sacramento River. He swam farther and farther and for three weeks resisted all attempts to drive him back down. People banged on pipes in the water, a method the Japanese use for driving dolphins. They exploded small cracker bombs in the water. They gunned the motors of their boats. Humphrey would turn downstream for a while, then, as quickly return upstream. After three weeks Humphrey was more than fifty miles upstream, and his skin was beginning to slough off because he had been in fresh water for a prolonged period. California authorities called a conference. There were about twelve of us on the phone from North America discussing Humphrey for about four hours. I suggested that instead of driving Humphrey, we try to lure him out using a particular whale feeding sound I and my colleagues had recorded. Nobody else knew of such a thing, so there was a great deal of skepticism. But mine was really the only plan. An hour or two after the conference, attendees called back and asked me to send a tape of the sound to them.

That was a Thursday evening, and by Sunday evening they were ready to test the system aboard a vessel called the *Bootlegger*. They got within about half a kilometer of Humphrey. Then, as all scientists do, they decided to calibrate their equipment. One of their investigators—a woman scientist—went out in a rowboat with a hydrophone [underwater speaker] to study the sound. When she got into position and signaled ready, the sounds started. Humphrey stopped in his tracks, wheeled around, and charged the *Bootlegger*. He caught everybody by surprise. They frantically waved the woman back onboard, put the boat in gear, and started downstream. Humphrey followed the vessel for fifty-three miles—seven hours—with the sound playing intermittently throughout—all the way back to the Golden Gate Bridge. The next day he was still in the Golden Gate area. The sound was resumed, and Humphrey followed the vessel under the bridge and out to the open ocean. He's been seen in successive summers since then, alive and well, feeding about twenty-five miles west of San Francisco.

Omni: How did you discover this sound?

Herman: We've been studying how whales manage their lives. In the open ocean we look at the whales' migration between their summer feeding grounds in Alaskan waters and winter breeding and calving grounds here in Hawaii. We're looking at social behavior and social affiliations as well as calf rearing and care. We identify individual whales and trace their behaviors, and we can identify them by photographing the tail fluke when the whale dives after being on the surface for a while. During some dives the whales throw their flukes in the air, nearly vertically. If you're close enough to film the characteristics of that fluke, you have a 'mug shot'—the whale's fingerprints. Joe Mobley, Scott Baker, Anjenette Perry, and I have just published a catalog of about twelve thousand whales we've identified in Hawaii and elsewhere.

Some years we've gone up to the summer feeding grounds in Alaska and studied whales during the other half of their lives. Up there it's a very different social structure. The whales are much more asocial in Alaska than they are in Hawaii, often feeding independently. Occasionally we see groups of whales who seem to be working together to corral schools of krill or fish. During collaborative feedings in Alaska, Scott Baker, who is a former graduate student now at the National Cancer Institute, recorded a sound that whales make while they're underwater corralling the food.

> *"Humphrey stopped in his tracks, wheeled around, and charged. They frantically waved the woman back onboard, put the boat in gear, and started downstream. The whale followed for 53 miles."*

Usually this sound comes from one whale who issues a series of trumpeting calls to the group, very much like an elephant call except louder. Moments later the whole group of eight to ten whales erupt vertically through the surface like missiles being launched, mouths agape, and they polish off the school. We used this 'feeding sound' in the spring of 1985 during some playback studies with an underwater loudspeaker in Hawaii to try to understand vocal communication.

From our sixteen-foot Boston Whaler we used an underwater loudspeaker, weighing one hundred and twenty pounds, powered by an eight-hundred-watt amplifier in order to produce something that sounded whalelike. We played back copies of songs the whales produce here on their winter grounds. As a control we also played back this Alaskan feeding sound because we wanted a sound the whales made that was not relevant to their presence in Hawaii. Mobley, Adam Frankel, and I discovered that about twenty percent of the whales targeted with this feeding sound literally stopped in their tracks and, perhaps from a kilometer or more away, turned and charged toward our small vessel. No other song reliably provoked such a totally unexpected and dramatic response.

Omni: Are they drawn to the winter songs in the same way?

Herman: They didn't approach our underwater speaker in response to song. Roger and Katy Payne have shown that during the winter, male whales sing long, complex songs consisting of a series of themes repeated in a certain sequence. To go from theme one to, say, theme six may take twelve to fifteen minutes. The song then resumes with theme one and repeats the sequence again. During that time the whale may be about sixty to one hundred feet under, usually alone, head down at about a forty-five-degree angle, big pectoral fins spread out. Multiple whales may be singing at the same time, but not in synchrony.

Now the obvious analogy is to male birds singing to attract females. And with birds you see females coming in and associating with males. The song of the bird serves to deter other males as well. But neither we nor anybody else has seen direct evidence that these whale songs serve a reproductive purpose. They may enable a male to create a sort of sound space around himself. Possibly a female listens to the song of a particular singer, comparing it to other songs to make some judgments about the 'fitness' of the singer. And perhaps she then issues some signal to that male, possibly a vocal signal, that tells him to come to her. We do see singers stop singing and leave and join other groups.

We've hypothesized that the singing may serve to synchronize females' ovulation, to bring females into ovulation at a time when multiple males are present, so copulation, when it occurs, is likely to result in impregnation. These whales have traveled thousands of miles to the breeding ground. They've invested a lot of time and energy in getting there. What a shame to go back without reproductive success. Old whaling records show that the vast majority of females killed on the way back from the winter breeding grounds were pregnant.

Omni: Do animals, especially whales and dolphins, have consciousness?

Herman: I would say yes, but that's a slippery term. It's better to ask questions that can be answered by experiment. Are animals aware of themselves? Do they have images and representations they can re-

fer to? Consciousness does not necessarily require language. You can be aware of your feelings, your bodily states, or nonlinguistic inputs such as touch. Language allows us to report on what those states are but language is not necessary for the existence of such states.

Omni: What is your definition of intelligence, then?

Herman: From my point of view and that of some other people who work with animals, we generally mean flexibility, the ability to change behavior. Intelligent animals are able to construct a detailed image of the world based on experience and accumulated knowledge. An animal needs to construct fairly detailed models of reality in order to behave, react, respond appropriately when different aspects of that reality emerge, including new aspects. Intelligence thus relies on the ability to store and utilize new knowledge along with strategies and rules that have been learned or that may be devised.

Omni: Can animals think?

Herman: If you define language as the sole source of thinking, the answer is no—if you say animals have no language. That remains to be seen. The question for researchers is to determine what aspects of language may be acquired by animals and to what degree. We should never expect animals to approach even the capabilities of the young child in language performance as we would not expect a human to approach the capabilities of a dolphin in swimming. Perhaps a dolphin would not call what we do swimming. Our task is to define the limitations and abilities of dolphins and other animals for languagelike behaviors.

Omni: Is intelligence different from one species to another?

Herman: Any species demonstrates intelligence to the extent that it demonstrates appropriate flexibility in its behavior. For example, we've shown dolphins can remember new sounds heard after delays of several minutes. They can also remember things briefly shown to them after delays of several minutes. But when you present this kind of result to an animal behaviorist, he might say that's not very impressive. After all, critters called digger wasps can remember for hours the status of food stored in their nesting holes. These wasps dig holes in the sand and lay their eggs there. When the eggs hatch, the larvae need food. Each morning the wasp visits the various nesting holes, takes an inventory of the food, goes out, gets food, and restocks the holes of those who need it, in the amount needed, based solely on what she remembered from the morning rounds.

That certainly exceeds our demonstration that dolphins remember for minutes new things heard or seen. But when you pose to the zoologist the question, "What else can the digger wasp remember?" you get a blank stare. The wasp is biologically engineered to remember the status of its nesting holes and virtually nothing else. In contrast, the dolphin is capable of remembering totally arbitrary events of no relevance to its natural world, of no relevance to what's biologically important. And it can report its memory in ways that are totally arbitrary, that are not the natural conventions of the species.

As another example, when a bee flies back after foraging and, through its ritualized dance, indicates a large abundance of nectar at a certain angle and distance from the nest, that's an impressive demonstration of symbolic reporting. And it's delayed reporting as well, in that there may be an appreciable interval of time since the bee found the flower. Again, however, what else can the bee remember? Can it remember things that have no biological relevance? Things that are completely arbitrary? Probably only with limited capacity at best. Can a bee report explicitly that there is no nectar?

"If I were a dolphin, I'd most admire my ability to go beyond what's necessary, to process information having nothing to do with my experience within the natural world."

The answer seems to be that it can only give positive reports. In contrast, in our studies we have shown the dolphin can report the absence of objects as well as their presence.

And absence is information. By reporting the presence or absence of some Frisbees in his tank, the dolphin reveals exceptional flexibility. The dolphin can understand references to objects or relations among objects having nothing to do with the dolphin's experience in the natural world and having no relevance for survival or reproduction. I think if I were a dolphin or any animal, I'd admire this kind of talent, the ability to go beyond what's necessary to what's arbitrary.

Omni: Can dolphins imitate sounds from human voices or computers?

Herman: We've presented Ake with a variety of computer generated sounds through a hydrophone. The dolphin listens to the speaker, turns to an adjacent underwater microphone, and then whistles in imitation of that sound. The dolphin reliably imitated a wide variety of whistle sounds—pure tones of constant frequency and frequency-modulated whistles. We extended this work by assigning some sounds to objects. After training, the dolphin was shown an object such as a ball, hoop, or Frisbee and reliably responded with a particular vocal label. In general, dolphins exhibit a great deal of vocal flexibility.

Mark Xitco, a former graduate student of my lab who is now working at the Living Seas Pavilion at Epcot Center, has shown the dolphins' ability to imitate other dolphins or humans. In these studies one dolphin served as the model, and the other as observer. The observer could imitate the model's behavior immediately or even after delays as long as eighty seconds. The existence of both capabilities, vocal and motor mimicry, has yet to be demonstrated in other species besides humans and dolphins. Birds may be wonderful vocal mimics, but they aren't capable of motor mimicry. Monkeys are good motor mimics but aren't capable of vocal mimicry.

Omni: Do you think the vocal repertoire will be extended to human–dolphin communication?

Herman: Not easily. The problem is, we don't have any instruments other than the human ear to identify a sound the dolphin produces. As the dolphin's vocabulary of sounds increases, it becomes very difficult for the human ear to make reliable judgments quickly. So we had to abandon that path. But we have two new dolphins who are being trained in both gestural and acoustic tasks, which opens the possibility of dolphin–dolphin communication. Our planned approach will use keyboards on which keys represent words. Dolphins themselves make vocalizations, but so far no one has evidence that these vocalizations have properties of language or that they even act as symbols. We've been studying that very carefully.

Omni: I observed two dolphins who were separated from each other by a board. One was told to jump over an object, and the other, whose eyes were covered, was told to "mimic" this behavior. How is it that the second dolphin imitated the first dolphin perfectly?

Herman: It's possible that the first dolphin was vocalizing in a way that communicated what the task was. It's also possible that by listening to the splashes accompanying a particular behavior, the observer dolphin could judge what behavior the other was performing. If one dolphin jumps over a Frisbee, the second may hear the first leave and reenter the water. The assumption the dolphin makes is that you jump over whatever's there. So hearing the sound, the dolphin might infer that the other was jumping over the Frisbee. It may be a nonlinguistic phenomenon not requiring vocal communication. Or maybe both are involved. It's always tempting to set up dichotomies, but often the truth is a bit of both.

Omni: Is their hearing that finely tuned?

Herman You're dealing with probably the best hearing in the animal kingdom. There's no doubt they can hear almost anything we produce in our tasks. But how they go about using that information is the question.

Omni Are you going to try to analyze the sounds they make?

Herman We have done some of this already. We've found that during the behavioral mimicry there are differences in vocalizations depending on the behavior performed. Again the question is: Do these represent some form of intentional communication from dolphin A to dolphin B, or are they arbitrary vocalizations that accompany a behavior, like a human who may squeal excitedly in one case or grunt in another? We are looking further into the issue in studies being conducted at our laboratory by graduate students Sara Parten and Kristin Jerger. Also, dolphins seldom give a visible identification when they vocalize. Peter Tyack of Woods Hole has been working out the technology to attach some simple receiver to a dolphin. When the dolphin makes a sound, a light glows on the receiver. In related work proposed by Richard Ferraro, we will attach an instrument that will place a time stamp on a vocalization. So from the recording, say, we will see that Phoenix was vocalizing at time 00010. And Phoenix's behavior during the vocalization was jumping over the hoop. Does that vocalization occur each time she jumps over a hoop? Does Ake make that same sound when she jumps over a hoop? This technology promises to open a whole new window to understanding behavioral communication.

Omni What other dolphin research is in the works?

Herman A whole bunch of studies using television technology. Palmer, Morrel-Samuels, Adam Pack, and I have recently demonstrated that dolphins can understand instructions given by televised images of signers [trainers making body signals] about as well as they can from live signers. The dolphin swims down to an underwater window. Behind the window is a TV monitor displaying a televised image of a signer being filmed in a remote location. The dolphin peers at the TV monitor, sees the signer, and carries out the behavior signaled by the sign or sequence of gestures.

We don't have to show the trainer's whole body; just his white hands in black space are sufficient, or even white spots of light dancing about the screen, tracing out the dynamics of the gestures. This capability by the way was not trained. We simply directed the dolphins to the underwater window and to our surprise, they immediately responded appropriately to the televised images.

We also tested the humans' response to these images. The dolphins' performance dropped somewhat during the trial in which they were exposed to white spots of light dancing about on the screen as compared to with hands or full body. We wanted to see whether this might prove difficult for humans, too. So we exposed twenty-one of our trainers to those same white spots and asked them to tell us what they meant. The trainers were divided into four groups: experts, intermediates, novices, and short-term volunteers. The results indicated that the dolphins performed better than all of these groups except for the expert group.

We're also looking at TV technology to see whether dolphins might understand scenes of dolphins or humans shown to them on television, and whether they use those TV images as models. So far our results are negative. We're also studying whether dolphins, like humans, have hemispheric brain specializations for various abilities. Now that we've taught an artificial language, is it specialized in one hemisphere of the dolphin cortex or the other to differing degrees? And more generally, are there various performance differences as a function of their complexity in the different hemispheres, as there are in humans?

"We exposed 21 of our trainers to the same dancing spots on the screen. The results were that the dolphins performed better than the humans did, except for the expert group."

Omni Phoenix and Ake are trained in two different languages. Do these languages have different grammatical rules?

Herman Yes. We construct two kinds of sentences when we give dolphins commands. One called the nonrelational instruction asks the dolphin to take an action toward a specific object. For example, "Pipe tail-touch" means "Touch any pipe with the tail flukes." The other kind, called a relational sentence, asks the dolphin to construct a relationship between two objects by taking one object to another object or putting one object on top of another. For the relational sentences the grammar and word order are different. The acoustical language taught to Phoenix uses a left-to-right grammar for relational sentences in which the order of instruction corresponds to the order of execution. If we ask Phoenix to take the ball to the person, we would express it as "Ball fetch person." To test whether the dolphin was just responding to each word in turn and never making an integrated response, we created what we call an inverse grammar for relational sentences. For the dolphin Ake trained in the gestural language. To tell Ake to take the ball to the person, we say, "Person ball fetch." Ake thus has to integrate all the words in the sequence to interpret what she should do. Our analysis calls the destination the *indirect* object, whereas the object manipulated or carried is the *direct* object. The grammar for Ake is indirect object plus direct object plus relational term. In Phoenix's language it is expressed as direct object plus relational term plus indirect object.

Omni What have you *not* been able to teach dolphins?

Herman We don't understand why the dolphin hasn't learned certain things. We attempted to teach the concept of "not." The idea was that "not" would serve as a logical modifier to precede an object term. For example, "Not ball over" meant "Jump over anything but the ball." We tried unsuccessfully for eight months to teach "not." The dolphin seemed to grasp the meaning at times; at other times, it seemed the dolphin was attempting to interpret "not" as an object term.

Another difficulty involves teaching concepts of large and small. We used a large and small hoop, a large and small basket, and a large and small ball. We created particular gestures for large and small. Then we might sign, "Large hoop tail-touch," or "Small hoop tail-touch." As long as the dolphin was shown the hoops in advance and the hoops were placed in the water within her view, she could respond reliably. Problems occurred when we attempted to generalize beyond that initial context.

Omni What happens when the dolphin is asked to react to an anomaly—carry out a task that is impossible or respond to a nonsense word?

Herman We presented dolphins with three different kinds of anomalies. In the semantic anomaly we ask something like "Take the window to the surfboard," the window being a permanent fixture in the tank. Instead of going to the window, the dolphin may go to some other object and take it to the surfboard, a substitution response rearranging reality.

Stricter examples are where no approximation is involved. For example, when asked to swim through a hoop lying flat on the tank bottom, the dolphin raises it in order to swim through. Or if asked to jump over a surfboard that's resting against the side of the tank, the dolphin will swim to the surfboard, move it out to the tank center, then jump over it.

In lexical anomalies we substitute nonsense words for known words. If the substitute word was an action word—if you said "Ball glub" instead of "Ball over"—the dolphin will simply refuse to carry out the behavior. If we substitute a nonsense word for an object term, "'Glub over" the

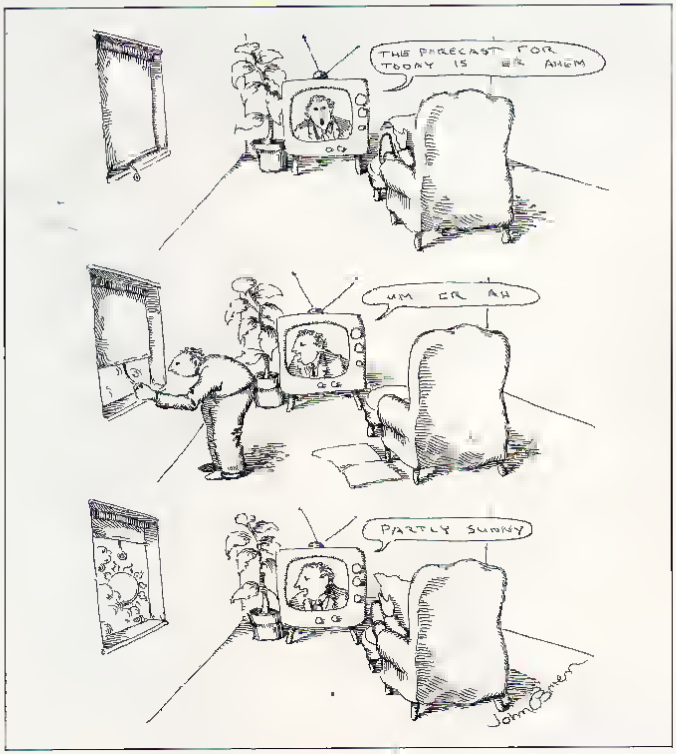
dolphin will pick out whatever object it wishes and jump over it. In syntactic anomalies, instead of saying 'Hoop ball fetch,' we may say 'Fetch hoop ball,' a rearrangement of word order. Or we might create a string [of words] in which there was an embedded grammatical segment with extra words added such as "basket hoop tail touch." In a number of cases the dolphin extracted the embedded grammatical segment out of the longest string and operated on it. Generally, our results with syntactic anomalies show the dolphin is very sensitive to word order and violations of word order.

Omni: University of Pennsylvania psychologist David Premack has claimed that the items dolphins respond to are all concrete, that human language consists of abstract items, not just objects, properties, and actions. Have dolphins shown they understand abstract concepts?

Herman: One has to question the validity of Premack's analysis in the first place. He was trying to say that objects, properties, and actions are rather simple things that any animal could point to an object, while language deals with abstractions. In fact, language mainly consists of words that refer to objects, properties, and actions. And with animals we simply express symbolically through words the objects, properties, and actions, or their relationships, that we wish the animals to attend to.

The question is, Does the dolphin have a concept of what the word refers to? The word *ball* doesn't refer to a particular ball; it refers to "ballness." Words and the things they refer to are not equivalent. Objects may have functions that exceed the boundaries of the word. If we sit on the floor and put our dinner on the chair, the chair is a table at that point. To the extent that the dolphin understands the words in her language as referring to concepts, such as "ballness" or "throughness" or "hungriness," yes, the dolphin is showing awareness of abstractions.

We did tests to see, for example, what a hoop is to a dolphin. A hoop is not just the hoop used in training the animal. It's anything with an opening in it, relatively large to its perimeter. So we have round, square, and little hoops, hoops that float and hoops that lie on the bottom. All of these are "hoop," when you use the symbol for *hoop*. With respect to actions, if we teach the dolphin to go under something, is "under" restricted to that object, to going under a certain way? Or is there a concept of being or passing beneath, or "underness"? We see that the dolphin in fact really has a concept of "underness." She will pick up a hoop lying flat on the bottom of the tank, raise it up vertically, and then dart under it in order to carry out the "hoop under" command. She manipulates the world so that she can create that action.



And this is absolutely not trained. In general, dolphins have fairly broad concepts of words they're given. With children we see the same kind of thing. As they begin to develop, they broaden and sharpen the boundaries of words. We shouldn't lose sight of the limitations human beings have in learning language when we discuss the limitations these animals have.

Omni: Are there other techniques that you have used to measure dolphins' ability for abstraction?

Herman: Perhaps a more telling test of their ability to form representations and abstractions occurs in the "referential reporting" procedure, where the animal understands a reference to an object that's absent. Investigator after investigator has put his finger on the ability to refer to events or objects displaced in space or time as a key aspect of human language. That's what enables us to discuss the future, past, or some other location as opposed to where we are now. Lack of this has been seen as a limitation in animal performance, animals being viewed as operating primarily in the here and now. It's only been recently demonstrated by Sue Savage-Rumbaugh, a psychologist at the Yerkes Primate Research Center, that apes are able to understand a reference to something that is not in their presence.

Premack, in his 1986 book, basically dismissed comprehension of "motor commands," as he called them, as saying anything about language competency. Asking dolphins to jump over a ball or over something, he said, is a limited procedure that does little justice to the ability to use language to access knowledge about the world. Then he says, "A language-competent individual who knows about tigers, for instance, can answer questions about them, even though no tigers are in view. And similarly, a language-competent dolphin who knows about the usual disposition of objects in a tank should be able to answer questions about these matters, although they are not in view."

In our reporting studies we asked the dolphins exactly that. What is the disposition of objects in your tank? Is there a Frisbee, a ball, a hoop? And Ake responded by repeating that a particular object was present or that it was absent.

Omni: Do you think that terms developed for human language competency should be used when one is assessing animal competency?

Herman: Some feel that you should use a term only if you can demonstrate that the animal uses it in all the ways a human does. That's obviously unduly restrictive. A dolphin might think that humans don't demonstrate swimming ability until we've demonstrated all the things a dolphin can do, like leaping fifteen feet from the water, staying underwater for fifteen minutes, swimming at twenty knots, and so forth.

CONTINUED ON PAGE 97

Existing international space law does not cover the eventuality of contact with extraterrestrials

ANTI-MATTER

UFO UPDATE

Astronomers involved in the search for extraterrestrial intelligence—or SETI—continually scan the heavens for radio signals from advanced societies. But what would they do if contact were actually made? That's the question asked in "The SETI Protocol," a document written by U.S. State Department official Michael Michaud.

Presented at the recent International Astronautical Congress in Bangalore, India, the protocol is meant to be signed by all astronomers involved in the search for extraterrestrial life. The goal of the document, to reduce the chance of a hoax or the premature announcement of contact, explains Michaud, director of the State Department's Office of Advanced Technology. The protocol, he adds, would also require that signatories make the discovery public. Alien messages would thus belong to the world, not just to a single university, organization or government.

According to political scientist Allan Goodman of the Georgetown University School of Foreign Service, one of the protocol contributors, there are good reasons for drafting the document. First, he says, alien contact is not covered in any existing international law or protocol that deals with space. Second, in talking to SETI investigators, Goodman has found some who would be inclined to keep extraterrestrial contact a secret and some who felt that it should be treated like any other scientific discovery.

As far as Goodman is concerned, neither approach will do. "It would be the most dramatic scientific announcement in our lifetime," he says, "and must be treated as such."

Toward this end, adds protocol contributor and NASA Ames Center researcher Jill Tarter, "we are just trying to reinforce the need for caution within the scientific community at the same time as we convince the public that extraterrestrial contact *will* be announced."

Even so, not all SETI investigators are behind the protocol. Paul Horowitz of Harvard, for example, says, "I am strongly apathetic." He believes SETI is no different from any other scientific issue and that "science will take care of itself." Would Horowitz sign? "If I think it is reasonable and stands for motherhood and apple pie and basically strives to remind us all of what good science is."

The chance to sign this document will probably come soon. Protocol proponents plan to obtain the endorsement of the International Academy of Astronautics and the International Institute of Space Law, according to Tarter. Then they will try to convince international scientific bodies like the International Astronomical Union. After that, says Tarter, "all individuals and institutions that we can identify who are taking part in any SETI activities will be approached." Even though the protocol could not legally bind a government, Goodman says that the final step will be to ask governments to sign as well. A separate question, of course, is who will speak for Earth once contact is made. Originally a part of the protocol, this issue will now be the subject of a further document. The reason? It turned out to be such an emotional issue, says Tarter, "that we are giving it more careful and deliberate thought." —*PAUL McCARTHY*

MOODY'S CRYSTAL BALL

The psychiatrist who made the near death experience a respectable subject of scientific investigation is now exploring the mental landscape with a tool made popular by fortune-tellers—the crystal ball. Dr. Raymond Moody, a professor of psychology at West Georgia College, is using an ancient method of divination called scrying to explore the unconscious mind.

Scrying, which comes from the word *descry*, meaning "to reveal," involves staring intently into anything from a clear mountain lake to a polished mirror or crystal ball.

Cultures all over the world have made the discovery that people gazing into a clear depth will have remarkable visual experiences," says Moody. These "visions" may contain faces of people known and unknown, childhood memories, or even minidramas involving the characters in one's life.

While scrying has long been associated with the occult, Moody doesn't think there is anything paranormal about the practice. "The images reported by my patients seem indistinguishable from hypnagogic imagery," he says, referring to the images that people commonly report as they drift off to sleep. The only thing even remotely uncanny about these images, from the unconscious, adds Moody, is that people report the imagery as arising from within the crystal ball, mirror, or whatever they are using.

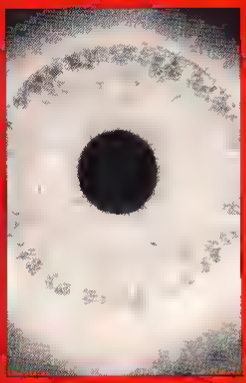
Of the 100-plus people he has worked with, Moody says, more than half have reported seeing images in a crystal ball. For this reason, Moody believes that scrying can be a useful psychotherapeutic technique. Scrying, he adds, may be more effective than the traditional Rorschach test, which involves interpreting a series of inkblots. "Because the person is gazing into a clear depth," he says, "you know that what the person sees is plainly coming from within."

Psychiatrists and psychologists are generally unfamiliar with scrying. "I've never heard of it," says psychiatrist Stephen Barrett of Allentown, Pennsylvania, "and haven't the slightest idea if it's valid."—Patrick Huyghe

THE EYES DON'T HAVE IT

Iridology, the practice of diagnosing disease by examining the iris of the eye, is common in the Netherlands, Germany, and England. Practitioners, in fact, claim the iris contains a map of the body's organs. A discoloration in one area, they say, indicates lung disease. Shadows in other regions point to problems with the kidneys.

But can iridology possibly work? To find out, physician Paul Knipschild of the Department of Health Care Research at the University of



Limburg in the Netherlands recruited five iridologists, including two M.D.'s. He showed these practitioners 78 slides. Half depicted the eyes of patients known to have inflamed gallbladders with gallstones (a disease recommended for the study by the iridologists themselves), and the other half showed the eyes of normal controls. The idea was to determine who had gallbladder disease and who did not.

But, Knipschild found, the iridologists could not tell the difference between a gallbladder patient and a healthy person. They picked the gallbladder patients only 50 percent of the time. Even more embarrassing, the diagnosticians could not agree as to who was sick and who was not.

Knipschild says he knows of a few other studies that obtained findings similar to his own. "So in general," he concludes, "we believe there is no empirical evidence for the diagnostic value of iridology."—Paul McCarthy

FAMOUS GHOSTS

Famous people sometimes seem bigger than life. And according to *Ghosts of the Rich and Famous* (Contemporary Books) author Arthur Myers, some of them also appear to be bigger than death. For example, there are reports that long deceased Clark Gable and Carole Lombard are still carrying on their love affair in an Oatman, Arizona, hotel and that a light bulb from the theater where Judy Garland last performed in New York glows with her energy 20 years after her death.

People who become famous usually have a tremendous amount of drive and a certain amount of exhibitionism, Myers says. So perhaps they are more likely to want to come back and influence people.

Myers says he's convinced Mamie Eisenhower haunts the home she shared with Ike near the Gettysburg battle field. The National Park Service has had many reports about her. He says, "Some of the park rangers were scared out of their wits by the ghost and threatened to quit."

Although the death of Marilyn Monroe was officially pronounced a suicide, Myers reports that the sex symbol has returned repeatedly to tell psychics that her death was an accident. She also supposedly appeared as a ghostly figure in a photograph taken of her grave.

The busiest celebrity ghost, says Myers, seems to be John Lennon, who has been seen by several people (including Beatle Paul McCartney) and is communicating through numerous channelers. "John is popping up all over," Myers explains, "because he was cut off before he could accomplish what he wanted. He's still trying to get out his message to give peace a chance."

Psychologist Robert Baker of the University of Kentucky calls Myers's book "unintentionally hilarious. I'm sure some people take it seriously and believe Gable is still shacking up with Lombard," Baker says. "Not many people are scientifically literate. Some have primitive notions about how the universe works, including beliefs about the dead hanging around and having power over the living."

—Sherry Baker

Beware the dead. And hail them. They teach you drunkenness. You have your own place to drink. Hail and beware them, when they come.

—*Charles Olson*

CORPSE COLLECTION

When representatives of Florida's Department of Professional Regulation visited the Howell Morning Glory Chapel funeral home in Jacksonville last summer for a routine inspection they suspected something was amiss. Eight unembalmed bodies were found rotting in a front room.

Although Morning Glory Chapel's owner, Lewis Howell, explained that he had been unable to dispose of the bodies because he couldn't reach family members or because the city had failed to give him the proper paperwork for indigent burials, the state inspectors called the police. 'We got there and started snooping around. That's when we found out how gross the situation was,' says homicide detective Lieutenant Jim Suber. Several rooms were filled with bodies.

In all, 45 corpses and the cremated remains of another 26 people were discovered in the funeral home. According to Special Assistant State Attorney McRae Mathis, some of the dead had been lying around since the late Seventies, while others were of fairly recent vintage. Several bodies were stuffed together in coffins, some were in bags, and others were stacked vertically in a storage room. The corpses were not embalmed or refrigerated but had been sprinkled with lime in an attempt to reduce the odor of decay. 'They were in various stages of decomposition—from mummified to skeletons,' Mathis says.

Why was Howell keeping a collection of corpses around? Mathis explains that many of the deceased were indigents and Howell took money from the city of Jacksonville to bury them. Instead, he pocketed the cash and stuffed the bodies into empty rooms. 'In some instances, there were indications that he did have a body in a coffin for showing to relatives. But if the family didn't want to go to the cemetery, he just used a coffin for viewing, dumped the body on the slack, and reused the coffin.'

The bodies have finally been properly buried, and Howell was recently convicted of grand theft and sentenced to a year and a day in prison. 'A special condition of the sentence,' Mathis says, 'was that he forever revokes his right to be a funeral director—anywhere.'

—Sherry Baker

DIAMOND TUMOR

When gynecologist Harold Burton of Roseville, California, discovered a swollen mass about six centimeters wide near eighty-year-old Virginia Argue's right ovary, he feared the worst. 'When there's an enlargement like that in an older lady, you automatically think *ovarian cancer*, which is a very lethal disease,' he says. But when Burton operated on his patient, instead of excising a malignant growth from Argue's body, he removed a benign cyst that held a shiny, square-cut diamond.

The gem apparently found its way into Argue's reproductive tract some 52 years ago when she delivered a daughter by Cesarean section. 'It's the only time her abdominal cavity was ever open before,' says Argue's husband, Rollo. 'We assume the diamond fell off jewelry worn by a doctor or nurse.'

Although he's never heard of a precious stone being retrieved from a patient before, Burton says that a cyst growing around the gem makes medical sense. 'I can understand how it happened. The ovary just grew a cyst around the diamond to protect the body from an irritating foreign object.'

Rollo Argue emphasizes that finding a diamond inside his wife wasn't half as exciting as discovering that she didn't have cancer. The diamond that was a part of Virginia Argue, however, will soon be on her person instead of in it. 'It's a tiny diamond,' he says. 'But I'm having it mounted so she can wear it on a necklace.' —Sherry Baker

---

Aristotle would have avoided the mistake of thinking that women have fewer teeth than men by the simple device of asking Mrs. Aristotle to open her mouth.

—Bertrand Russell

DOLPHINS

CONTINUED FROM PAGE 48

million years ago." Qualitatively the dolphin neocortex bears more resemblance to the brain structure of the hedgehog—whose cortex evolved more than 100 million years ago—and of the bat—another ancient brain—than it does to those of modern land animals.

The "advanced primate" neocortex, for example, is built of densely packed columnar structures: vast groupings of neurons stacked like coins. These long, narrow columns are the basic processing units of the cerebral cortex. Using advanced imaging technologies, Morgane and Glezer have recently discovered that dolphins have fewer of these columns than humans, though the dolphins' are wider in diameter. The microcircuitry too is less complex.

On land, mammalian neocortices evolved, becoming more specialized. Many land mammals, including humans, have associated sensory systems sandwiched in layers between areas of the primary cortex. These cortices are thought to be crucial to learning and emotion—the connective tissue that allows us to associate sensory information with memories and feelings. For instance, the smell of pine can evoke thoughts of Christmas past. In the dolphin brain the somatosensory areas—vision, hearing, touch—remain more generalized than those of land mammals. "Maybe most of this cortex is an associational cortex," Morgane muses, "and it did not go on to specialize. The last stage of cortical evolution—the formation of primary sensory and motor regions—did not take place."

In 1986 Harry Jerison, a microbiologist at the University of California Medical School, proposed that given the dolphin brain's close positioning of the laminates of the neocortex, motivational functions such as intimacy and feelings may be more active in the dolphins' neocortical processes than in humans', and their thoughts more emotionally charged.

He also theorized from research on bats that huge areas of their brains are devoted to a sophisticated echolocation system. Given the enlarged dolphin neocortex, he proposed, the dolphin echolocation system may have evolved to the point where it creates the dolphin's "reality." Dolphin echolocation processes may operate as visual processes do in humans, creating both perception of the outer world and of the self.

It has already been demonstrated that bats can intercept one another's signals, something done not at the cortical but at the subcortical or midbrain level. This kind of interception could mean they could share perceptions about the external world. Within its perceptual world, the dolphin may not have constructed an individual but a communal sense of self," says Jerison.

Norris is not willing to accept this group-consciousness idea. "There is no question dolphins pick up a lot of information by listening to each other's echoes," he says. "And I think the idea is engaging, but there is no proof. We do have evidence that when they echolocate, they avoid spraying each other with sound. They have a thing we call dolphin echolocation manners. They simply shut down their gear. They have developed a window to spray the environment, but not each other, with sound."

He is also unconvinced that dolphins have language. Instead, he hypothesizes, there may be a more ponderous, multilayered, emotionally based communication system. "It's more like music," says Norris. "There is a lot of rhythmicity, multiple messages carried in beats," such as a single whistle that identifies one dolphin to another and at the same time tells

> *"Reports surfaced that during the Vietnam War, porpoises were sent to Cam Ranh Bay to guard ships. With lances strapped to their beaks, the dolphins supposedly skewered enemy frogmen."*

that dolphin that there is trouble.

Some researchers, however, describe Jerison's notions of a communal consciousness as "philosophical and "ethereal." Jerison seems to be proposing that the dolphin sees the world differently than man does— which it may. Morgane says, "if it has a different brain. It's like an alien from another planet or Atlantis."

Researchers from SETI, the search for extraterrestrial intelligence, would probably agree which is why a number of space agencies have taken a keen interest in the research of Dianna Reiss, an animal- and human-communications professor at San Francisco State University and director and founder of Project Circe at Marineworld Africa, USA in Vallejo, California. Reiss's work decoding dolphins' communication systems seems similar to the quests for extraterrestrial intelligence. In 1987, in a paper before the International Astronomical Union in Hungary, Reiss, who was a guest speaker at a recent NASA conference and the recipient of a grant from the Pasadena, California-based Planetary Society, spelled out the problems the two quests share. "How do we detect signals and recognize patterns when we are unsure of the nature of the signal?" she asked. "How does an observer of one species penetrate the communication system of another when we are really deaf and blind to that system?"

During her eight-year study of four bottle-nosed dolphins, Reiss has concentrated on analyzing both vocal and nonvocal signals. Much like the work Louis Herman is doing, Reiss constructs "ethograms —a behavioral code—by watching and videotaping the dolphins, tape-recording her observations, then sorting their behaviors into categories, searching for a relationship between the dolphins' sounds and their other behaviors.

Reiss has also designed an underwater keyboard of nine keys that the dolphins can manipulate. Each time a dolphin pushes a key with its beak, a computer records it and produces a sound specific to that symbol. Then the dolphin gets what it asked for: a ball, fish, and so on. Soon after she installed the keyboard, the dolphins taught themselves to use it, imitating the computer whistles they would hear after pushing the keys, and incorporating those whistles into their own vocal repertoire. This suggests that they were learning to associate key whistles with visual signals.

Not all research has been so benign. Currently most financial support for dolphin studies comes from the US Navy, an organization recently accused of abusing the marine mammals in its program. In the past four years, $30 million has been spent on work the Navy refers to as research into "marine biological systems" with dolphins, sea lions, and beluga whales. During the past 30 years, the Navy has trained 240 animals at secret facilities in Hawaii, Key West, and San Diego and has published more than 200 papers on its research into the dolphin's sonar, diving and retrieval abilities, and anatomy as well as the electrical activity of the dolphin brain. But there is much public interest in what the Navy will not disclose, which appears to be plenty.

Navy marine mammal research began in the late Fifties, says Norris, when officials hired a group of young marine mammal workers to find out what could be learned about dolphins to aid the Navy with military missions. They sought to reduce hazards to divers and to develop a dolphinlike sonar or hydrodynamic torpedo that could move through the water as easily as a dolphin, says Norris.

"The Navy was the best organization I've ever worked with in terms of support and unencumbered bureaucracy. They bet on people who had innovative ideas and stayed with them. But I'm opposed to things under security wraps and have no interest in being involved in dolphin monkey business such as using dolphins for sinking ships," he says, referring to rumors that dolphins were deployed in

the Persian Gulf to detect Iranian mines and sink enemy vessels

The Navy has been scoffing for years at accusations such as these, assertions prompted in the Seventies by the novel and film *The Day of the Dolphin*, which suggested that Navy animals were trained to carry explosive packs that blew up enemy ships. At about the same time reports surfaced that during the Vietnam War, porpoises were sent to Vietnam's Cam Ranh Bay to guard ships. With hollow lances strapped to their beaks, the dolphins supposedly skewered enemy frogmen with exploding air cartridges. The program, the reports alleged, was discontinued because the dolphins couldn't tell the difference between friendly and enemy frogmen.

Navy officials admit that the dolphins were sent to Vietnam for research into the animals' ability to detect military equipment in the murky waters. They have also revealed that dolphins were in fact involved in recovering torpedoes, detecting mines, and locating hostile frogmen in the Persian Gulf. And the Navy has publicly confirmed its plans to use 16 dolphins to guard the Trident nuclear submarine base in Bangor, Washington—an action 15 environmental and animal rights groups are trying to block.

The Navy's semiclassified program came under attack for another reason as well. Navy marine mammal trainer Rick Trout, on disability leave from his job with Seaco, a San Diego firm with Navy contracts, claimed the Navy was abusing the animals in its underwater defense training program. The program includes work with dolphins and sea lions. Trout alleged that drunken Navy trainers mistakenly drowned several sea lions by dropping them overboard in locked cages and that trainers kicked and starved animals that did not perform well.

In February a seven-member team appointed by the Marine Mammal Commission (MMC) to investigate Trout's claims reviewed files, records, and training sessions, and interviewed former Navy employees including Trout. The team found no evidence of "pervasive abuse," but they did recommend that the Navy add no more mammals to the program until it can hire more veterinarians. They also reported that the allegations were "substantially lacking" but found "there were elements of truth: isolated incidents of animal abuse and some shortcomings in the program." They recommended that a high level Pentagon official oversee the marine mammal program.

The fact remains, however, that Navy funding is essential for much of the research on dolphins to continue. And with recent cutbacks in the Department of Defense budget, even those funds are waning. Grants from the National Science Foundation (NSF) and other research organizations are coveted, and a university affiliation for a marine mammal

scientist is rare "The peer-review process at NSF has become very conservative in their support for new or risky projects. The Office of Naval Research specializes in funding this kind of innovative research," says Peter Tyack.

"What happens," says Norris, "is the National Science Foundation says, 'The Navy wants dolphin proposals; go see them.' So do we sit back and say our principles are being violated by dealing with a military agency? Or do we say, 'Well, as long as I keep my integrity intact, there's nothing I can do about where the government money goes?'"

Excluding the Navy 641 permits have been granted to date by the National Marine Fisheries Service (NMFS) for purposes of research and public display in the United States and last year the Marine Mammal Protection Act was amended to require that "dolphin swim" programs contain some kind of conservation or educational element.

The Marine Mammal Commission is currently reviewing the four permits granted to these programs where guests pay up to $55 to swim with dolphins. The original permits were granted "with reservations," says John Twiss, executive director of the Marine Mammal Commission. "We approved the NMFS permits but recommended that these swim programs be conducted on an experimental basis until the end of 1989 when preliminary data were available to evaluate them." The last "swim" permit to be granted was to the Hyatt Waikaloa on the Kona coast of the island of Hawaii, a megaresort with the largest captive habitat for dolphins in the world. At the Hyatt's Dolphin Quest scientists and trainers are merging research, education, and entertainment, and there is no question that it will be a profitable venture.

The habitat is a five-acre natural seawater lagoon, open to the ocean and teeming with tropical reef fish and mullet—fish the dolphins eat naturally in the wild. The space is so large, in fact, that the dolphins can choose not to participate by swimming away.

"Please remove your life jackets and put them on the dock," says dolphin trainer Christian Harris. "If you can hear me, I'll give you a hundred dollars." The group participating in the last phase of a half-hour dolphin encounter seem entranced as they dangle their legs into the natural lagoon that is home to six young bottle-nosed dolphins.

No one responds. Harris smiles and shrugs his shoulders. "If they go away with anything, it's with a greater appreciation and compassion for these animals."

The popularity of this program is obvious on examining the daily waiting lists for the $55 dolphin encounters. They number in the hundreds for the 40 spaces available under a lottery system. And of the 30 minutes allotted to the experience only ten are actually spent with the dolphins in the water, the other 20 consist of a lecture on dolphin behavior and anatomy. Dolphin Quest is the brainchild of marine veterinarians Jay Sweeney and Rae Stone, who plan to establish a marine science education program at the Hyatt as well as a nonprofit research foundation whose first project will be to help support Norris's studies of the social dynamics of Hawaiian spinner dolphins.

As the hazards of life in the open seas have increased of late, protected habitats may be among the few safe havens for dolphins. In the wild they are prey for sharks and tuna fishermen and recently were the victims of a mysterious plague. Two summers ago thousands of bottle-nosed dolphins died. Many of them washed up along the shores of the East Coast with lesions, pneumonia and bacterial infections.

In February a research team of North American scientists supported by the MMC, the NMFS, and the U.S. Navy attributed the dolphin deaths to bizarre movements of a bloom of toxic algae, or red tides, from the Gulf of Mexico. The dolphins, they said, died from eating fish tainted with the brevotoxin of the bloom. But environmentalists and other researchers are not satisfied with the government findings, suspecting that the cause of the deaths is directly related not to red tides but to the infectious and toxic wastes Americans dump into the oceans each year.

In Hawaii, where the glassy waters of the Pacific remain relatively free of human waste, bottle-nosed dolphins may have a better chance at survival. At dawn, when the Hyatt's dock is closed, the dolphins dart playfully across the lagoon, jumping in tandem between stone pillars, graceful as dancers. At dawn the sun rises over the quiet ocean. On the rusty-orange horizon, humpback whales breach into the light, their enormous figures charging like missiles from the water.

A few hours later the first group of swimmers enters the lagoon. The dolphins seem to welcome their presence, tossing balls, offering themselves for inspection and examining in turn these curious and sometimes fearful humans whose arms and legs they gently nibble.

Without question, swimming with dolphins is an uplifting experience. Despite the intrusion into their captive environment, they appear to unconditionally embrace humanity. Our communion with them is real, not imagined, reiterated time and again by the myriad scientists devoted to comprehending their "alien" intellect. "We're not on a pedestal some place, alone and magnificent. Dolphins are one branch of a tree we are all a part of," says Norris. "We are of them; they are of us, and the more we know about them and the other animals, the fewer the barriers there will be between us." ∞

Research contributed by Kathleen Stein.

BOOKS

CONTINUED FROM PAGE 30

the principal reason Timothy Leary's name doesn't appear on the foundation's roster. America's LSD guru remains too controversial and wasn't approached by the foundation. "If I were starting a legitimate foundation that needed to win establishment approval, I wouldn't invite me to be on the board either," Leary says. "My name is still too radioactively dangerous. My job now, as a performing philosopher, is to stir up controversy, and that's not what the foundation needs."

With the antidrug movement and the recent resurgence of LSD on the streets, the Hofmann Foundation would seem to have all the right elements to stir up controversy. But Janiger asks, "how can there be controversy over a library? Providing information is not advocacy. We are not looking to screen out the negative material. That will be there, too. We will be looking at the whole spectrum of LSD and other consciousness-oriented substances and techniques. The focus tends to be on LSD only because of its prominence." No one, he adds, is suggesting that everybody drop acid. "That's a tired old prejudice."

For now the Drug Enforcement Agency (DEA) is maintaining a neutral stance on the Hofmann Foundation. "If it is truly a place of learning, to collect the potential benefits, if any, of LSD, then we don't have any problems with it," says Raymond McKinnon, head of the DEA's dangerous-drug unit. "If these people want to gather the material and take some legitimate looks at LSD and possibly reopen the issue, then they appear to be going about it in the right way."

Now in his eighties, Hofmann agrees that banning LSD in the Sixties was not only appropriate but necessary. "The accidents occurred because of the unwise and uncontrolled use of LSD, much of it in the wrong kinds of places, like bars," he says. "But many other people had good experiences with LSD. And we had so much more to learn."

Had someone like eighteenth-century Austrian physician and hypnosis pioneer Franz Anton Mesmer (from whom we get the word *mesmerize*) had the foresight to pull together all the information then known about hypnosis, the medical community would have been vastly enriched at a much earlier date. That, Janiger points out, is what he and others at the Hofmann Foundation are trying to do now for human-consciousness studies.

"Professionally and personally, I believe that LSD is one of the real milestones in the history of our understanding of the human mind. In a hundred years it will become apparent how vital and how much of a watershed these last twenty to thirty years have been in the understanding of consciousness." ∞

INTERVIEW

CONTINUED FROM PAGE 86

Otherwise we humans shouldn't call it swimming. We construct artificial languages and apply them to animals to answer questions about language competency. We can therefore hardly avoid using those language terms that are the focus of our studies, such as *semantics* and *syntax*.

Omni: You have emphasized language comprehension or understanding over language production or making speech. Why is that?

Herman: For two-way communication to take place, both language production and comprehension must be present. We've stressed comprehension for purposes of objectivity and control. Suppose you emphasize production—symbol making—and teach the animal a variety of symbols it can use, say, to request specific foods. You teach it a symbol for *M&M*, for *banana*, for *peanut*. When the chimp produces a symbol, it's difficult to decide whether it really understands the meaning of the symbol. What's the difference between the chimp giving the gesture for *M&M*, say, or pressing a lever to get an M&M? You don't know. Very often, the context in which the symbol is used is rather loosely defined, the timing arbitrary, and you can't exactly replicate it.

In contrast, an emphasis on comprehension means you provide the symbols, you construct the situation, and therefore you can describe exactly what that situation was. And you can objectively measure the animal's understanding by how and how well it responds to the symbols you provided.

Omni: You've said that Ake's performance has remained stable, but Phoenix's has begun to decline. What's behind this?

Herman: We're not sure. The acoustic language Phoenix uses is based on sounds generated by a computer through an underwater speaker. The computer produced the same sound each time. We suspect the stimuli, which were so invariant most of the time, aside from some computer glitches. Also, it wasn't a person providing the information. The extent to which a transaction lacks a social component may limit an animal's interest, motivation, or ability to perform well consistently in a situation.

Omni: Is that the only theory?

Herman: At this point, yes. There's also the possibility that it's a Phoenix problem, although Phoenix has been able to learn plenty of complicated things since then having to do with sound. She can pay attention to sounds when she wants to, and can report accurately on their characteristics. For example, in a melody-recognition experiment conducted by Jim Robbon, now a psychology professor at Indiana University, we presented Phoenix with two simple melodies. One is a descending series of notes, the other an ascending series. We used many different examples of each. We were asking whether Phoenix could learn to recognize these differences between two basic sequences and report them accurately.

Initially we tried to train her to respond to the paddle on her right if it was a descending series and the one on her left if it was an ascending series. For months we attempted to improve her performance, but she remained close to chance levels. And from time to time, trainers reported that Phoenix was making a lot of noise down there, seemed to be upset, et cetera.

One day I simply walked down, stood by the tanks, and listened to Phoenix. I should have done this earlier. After about half a dozen trials, I began to realize that Phoenix was spontaneously whistling in the presence of a descending series and remaining silent during the ascending series. I couldn't hear the sounds, but as the trainers reported back to me what they played, they became apparent. So I asked them to continue the series, and I'd point to the right or left paddle to indicate which way I'd think Phoenix should respond based on her vocalizations. Well, I was correct ninety-five percent of the time, using Phoenix's own information. So we simply chucked the paddles and listened to Phoenix. Her performance immediately improved to ninety-five percent correct, and she had no further trouble with the task.

> *"The loss of Puka and Kea was not just a setback but a critical junction in my life and career. It was a personal loss, like what you experience when a child you have reared dies."*

Omni: Did the decline in her performance have anything to do with boredom?

Herman: No, she doesn't seem to get bored doing the same thing, at least in our setting. As long as she's right, she loves it. I think Phoenix invented these behaviors, why I don't know.

Omni: In 1979 Herbert Terrace, a Columbia University linguist and psychologist, published a paper saying that researchers conducting animal language acquisition studies had been misled. The animals hadn't learned language but rather behaviors that produced rewards, and trainers were unconsciously prompting their subjects. Could his conclusion apply to your work?

Herman: The problem of inadvertent cuing certainly has to be dealt with. We've dealt with it by trying to eliminate all such possibilities. For instance, when we conduct tests, we use an observer who's blind to what information has been given to the dolphin. Also we carefully control the trainer's behaviors.

Omni: Can any other animals understand a change of word order?

Herman: Ronald Schusterman [at the University of California, Santa Cruz], who's adopted our experiments with sea lions, has recently shown that sea lions will distinguish among words according to their serial order, similar to what dolphins can do. So far he has only asked the animal to fetch one object to another.

Omni: But hasn't Schusterman been critical of your approach?

Herman: He recently criticized us for not having fully reported our training procedures. It was a specious criticism because he personally was advised of our procedures in his visits here many times. And we tutored him in these procedures during his training of the sea lions.

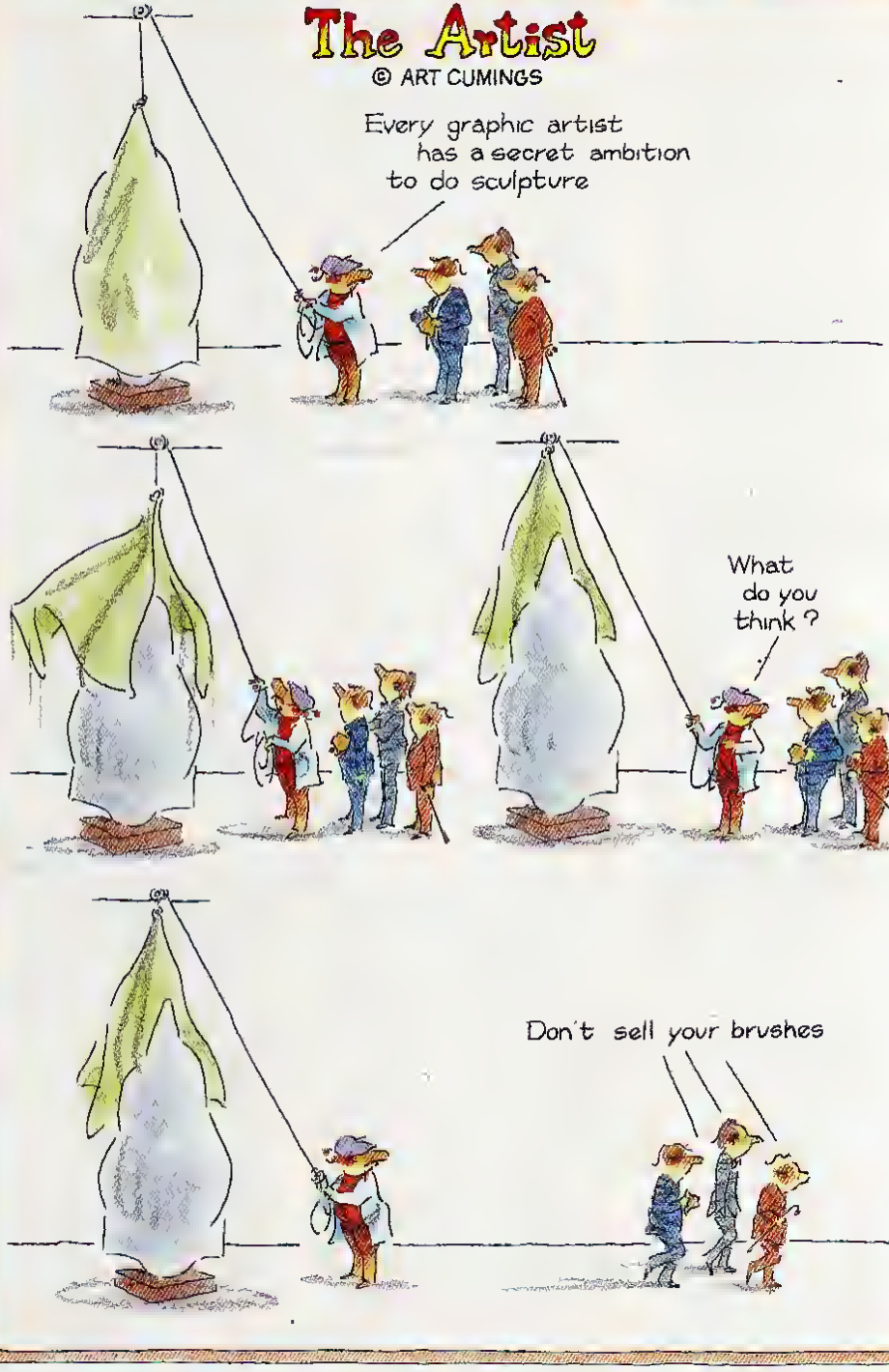
He has questioned our use of linguistic terms in describing or discussing the dolphins' responses. Schusterman prefers to use stimulus–response terminology, phrases like 'paired-associate learning' and 'conditional discrimination' as opposed to "words" or "sentences." But it seems reasonable that if your goal is to look at animal language competencies, you use language terms to describe those competencies. It's foolish to set up a program that admits you've constructed an artificial language, as Schusterman does, and then deny yourself the use of language terms to analyze your results. Also words have a great deal of intluence on how we think. Thinking in terms of stimulus–response terminology tends to drive us to view animals as automatons, to give them very little credit. If we open ourselves a bit, we may be surprised by what that reveals.

The fact that an animal gets a reward for a certain behavior doesn't invalidate his language. You may work for me for money and we may communicate about that work, but the money reward doesn't invalidate our use of language. If stimulus–response conditioning is appropriate, it can be used.

Omni: Why do most scientific journals today refuse to publish papers on animal language research?

Herman: Most will publish these articles, a few will not. The historical context is important. Animal language work during the mid-Sixties through the late Seventies was very promising and exciting. It was published in a number of journals, including *Science*. After publication of several articles by Herbert Terrace and colleagues in 1979, people began to take the attitude that it was all artifact, all trickery, that

The Artist



there was nothing to it. *Science* made a policy that they would no longer publish articles on artificial language in animals. This was around 1981, when postdoctoral associates Jim Wolz, Doug Richards, and I submitted our first dolphin research paper on language comprehension. It took us far too long to realize that policy and politics, not science, were at stake.

Omni: Have you suffered any setbacks in your years here?

Herman: The loss of the dolphins Puka and Kea in 1977 was not just a setback but a critical junction in my career and life. It was a personal loss, like we experience when a child whom we've reared dies. The lab was virtually destroyed because it had existed for these dolphins. It was shut down for fourteen months until Ake and Phoenix arrived. Not only was I affected, but all the staff and students who had put in so much time, tension, and love for these animals. The crisis was not just an incident but something that stretched out in time. There was not only the tragedy of the event but the fact that we then had to face a long trial process to bring these people to justice—the ones who had abducted Puka and Kea from the laboratory.

Omni: Are you currently planning any study of dolphins in the wild?

Herman: We have plans, but it's very difficult around Hawaii because they're not readily accessible. We're fortunate that there are studies by others of Hawaiian dolphins in the wild, most notably by Ken Norris. And we hope the sum of this information yields better understanding than any one project.

In most early work on dolphins in captivity, their social life was seen as a possible artifact: that they were really just caged animals and that their social behavior had nothing to do with their behavior in the wild. Work in the field, however, has shown the same social structures occur in the wild. So field researchers can look in the wild for certain features identified in captive animals in tanks; conversely, studies of behaviors in the wild may help us to interpret behaviors in captivity. If you see male aggression in the tank—a male tooth-raking and biting a younger male or even a female—is that an abnormality occasioned by the captive situation? We now know from field studies that large males do impose themselves aggressively on younger males and females with the exception that the animals can run away a little better in the field situation. So from the field studies you get an idea of whether you are creating a poor situation for the animals. And you're not.

Studies of captive animals can also lead to working better with captive animals trained for open-ocean work. There are many reasons to work with dolphins in the open ocean. They can make repeated dives without surfacing. And with special training they may be able to report to you on the presence of sharks or other predators. They can help you locate anything from sunken ships to bodies of drowning victims.

Omni: What are your future goals in dolphin research?

Herman: I don't have a lot of fantasies or far-out expectations. I don't find myself speculating as to where all this will take me. For example, I had not envisioned the success with TV communication that we have had. But this success evolved out of our findings about visual capabilities of dolphins, which in turn emerged from our language studies. Each study we do is typically motivated by questions raised by our previous studies. My goal is not to "talk" to dolphins or to "be with" them in the open ocean as we encounter some adventure or another. Right now I'm much more interested in communicating more effectively to dolphins and learning how they communicate with one another.

Omni: What do you see when you look at a dolphin?

Herman: When you live with a person or an animal for a very long time, you have responses to it you're not even aware of. You don't have first impressions anymore. It's difficult to analyze, but I think one develops a great deal of respect for these animals' abilities, not only intellectually but socially. I see social skills. I see curiosity. When you are with them at tankside, you're very aware of their attentiveness and their expectations of you. They expect you to do things with them and for them. Yet they're not dependent; they're independent. They love to play; they love to interact. We treat them with a great deal of care and respect, give them tasks that are satisfying to them as well as to us. There's a lot of worried mothers around this place if the dolphin doesn't take a fish, and many are bonded very closely to the dolphins.

Omni: What about you?

Herman: I have gone more from being at tankside to being in the back room planning and writing. It's more impersonal, and this isn't necessarily how I'd like to be, but it's a necessary concomitant to running a large research project. What I say about the trainers reflects things I have experienced over the years.

I don't think I or anyone else takes the point of view that these are "just" animals and therefore subordinate. It's pretty different from how you might relate to a dog. This is not obedience training. Our response to the dolphins involves meeting them on equal grounds. We're dealing with a very complex, very intelligent creature. And we're both doing the very best we can to communicate.

FICTION

TWO DISPARATE CULTURES, A TALENT NOT QUITE ACKNOWLEDGED, AND A MAN PLAGUED BY DREAMS MAKE FOR A VOLATILE MIX

LITTLE BOY BLUE

BY BRUCE McALLISTER

April 6, 1990 That night he dreamed of the leper again, and of the little Montagnard girl he had come to love who had died in Dak Lo. His own sounds woke him. He was weeping with a corner of the pillow wet in his mouth, and he was alone. Gala was gone, and the bedroom door was closed. To keep his sounds from the children.

In the morning he noticed a pillow on the living room couch and a blanket folded neatly beside it. The four of them ate breakfast in silence, with only one attempt at felicity from Gala. She spoke of a porcelain class she was going to take at the Y, and how she would be having lunch with a friend that day. He waited for the children to speak. Katie had a new kindergarten teacher, he remembered. The children said nothing.

He avoided contact with Stratton at the office, gave the Irvine contracts to the new man, and was unable to concentrate. When he came home forty-five minutes early, he found a note from Gala saying that she and the children were at Jack Tatum's. He knew she would never go there alone.

When he went to get them, Tatum grinned, shook his hand, and told him what good kids he had. That evening Gala's blue eyes avoided his, and even Aaron seemed nervous, as though he had been a party to it even at age ten.

The next morning, as he drove toward the freeway off ramp at Orange Street, he saw the first one. The boy was on a lawn in front of an apartment complex, squatting on his haunches. He was thin and dark, with delicate features.

He hadn't seen anyone squatting like that in years.

The boy was Vietnamese.

That weekend, as he drove his son to soccer practice, he saw four teenage boys, all of them lithe and confident, with ready grins. He passed them slowly, wondering where they lived.

Aaron said, "Is anything wrong, Dad?"

"Are they Vietnamese?" he heard himself say.

He thought of the young boys in Darlac Province whose left arms he and another medic had vaccinated, how those same left arms had been cut off by the NVA and piled in the center of the village—as an example.

Aaron said, "I don't know, Dad. They kind of look Japanese to me."

But they weren't. They were moving into town, family by family, and he saw the same four a few days later, near the high school again, where he had driven in the hopes of seeing them. They lived near the school. He was sure of it.

PAINTINGS BY GREG SPALENKA

For an instant as they stood undressing in the bedroom, her gaze moved down his front to the spot just below his waistband, just inside the jut of his hipbone, where the tattoo was. It was a small thing, but horribly intimate there, and he knew how grateful she was that it was always hidden, that their friends at the pool and on Balboa could not see it. It was of a tiger, tiny and exquisitely done, its eyes wide, its paw raking the air. He could not remember how he had gotten it.

That Saturday, while he mowed the lawn, the bag came loose. As he leaned over to reattach it, he watched the clippings and the red dust from the bare earth rise, beaten by the rotary blade. This close the grass seemed as tall as an elephant's legs. The red dust filled his nose and he swore. Even in the monsoon season, there was dust.

The rotors beat the air over him and he kept his head turned from the prop wash, his eyes squinting, his hand cupped to the right side of his face. He could hear the Chinook struggling overhead, overloaded with body bags, bumping the ground two, three times as it tried to gain altitude, the bodies weighing it down.

The fading sound of the rotors filled him with an emptiness.

"Ni Fa?" a voice said. He turned.

His wife was standing not far away, looking at him oddly. She had never called him that. Someone else had.

Her eyes were slits now, her skin dark, her young face as broad as a platter. *"Ni Fa?"*

Her lips, he could see, did not move as she said it.

This isn't real, he told himself. *It's happening to me because I was there. It's happening to the others, too.*

November 17, 1966. Her name was Moye. She was the niece of Lam, the village headman who spoke fluent French. She was eight or nine and he often thought she had chosen him from all the others because of his age. At twenty-one he was the youngest and greenest of the team, and she seemed to know this.

She was stocky, unlike most of the Montagnards, and her broad face made him think of grass skirts and hula dancers rather than rice paddies and triple-canopy jungles. Her nose was flat, her lips full, and her eyes wide set. Coming from those lips the patois of the Jarai—which he didn't understand and still wouldn't at the end of a year—made him laugh. It sounded like coughing.

They taught each other a few words and he gave her a strand of costume jewelry, swirling glass beads from Camp Goodman near Saigon. In return she gave him a brass bracelet and followed after him when he walked the perimeter, though he told her not to. She called him *Ni Fa*, which he found out meant "long brother." "That's awfully close to 'long pig,'" Carruthers teased him. "*Damn* close." They had both laughed.

He never picked her up. She never climbed up on his lap or asked to be carried piggyback or thrown into the air as an American kid would have. That was okay. She was a female, and the last thing the new A-camp needed was a misunderstanding.

They touched nevertheless—his hand on her shoulder, her hand in his—and when these touches brought no looks of disapproval from the adults of the village, the unease finally left him.

A few hours before the petrol was to leave—at sunset—she came to him. All day she had sat watching him on the hard-packed red earth of the village, ten or twelve yards away, looking into the shadows of the jungle whenever he glanced over at her from his packing. She was silent when she finally came, a woman's anger in her eyes, presenting him with her arm, the limp wrist, the only thing she could offer to make him stay. There was a scratch, not very deep, and he wondered how she had gotten it. The inflammation was all but hidden by the pigment of her skin, and her arms and legs, he realized now, were covered with the little pink scars of scratches just like it from the world she lived in. He simply hadn't noticed them before. He got out a first-aid kit and disinfected the scratch and fussed over the arm as he would have a broken doll. Then he put a bandage on it and waited. She did not leave. She stood there while he finished packing, and when he said "Good night" and went inside his hooch for a couple of hours of sleep, he heard her say something that also sounded like "Good night."

The banyan trees were beautiful. Their world was like a dream. They rose a hundred feet, and their crowns arched like endless umbrellas to keep the sunlight out. In the shadows below, the trunks grew like great gray knees from the ground, and he felt like a toy soldier in a fairy tale. In the yard of the abandoned French hospital, with its perpetual twilight, he saw the C-ration can. It was lying in the middle of the yard and he was the first to see it.

He walked toward it and the world flickered blue. Everything slowed.

He stopped, shook his head, and stared at the can.

He took another step.

The world turned blue again, slowing, and he stopped, dizzy.

The others had arrived, and one of the Jarai was heading toward the can.

He made himself take another step,

and the world flickered blue, stayed blue, and he started to speak, to say "No," but the Jarai was to the can now, leaning over, rising suddenly, driven skyward, splitting in half like a wet straw doll, the concussion a tremendous *No*.

That was the first time it happened.

Later that day, as he ran toward NVA fire, the world turned blue again and stayed blue. The banyan trees were blue. The AK-47 rounds were bluer still. They slowed as if in a dream, and he left himself, floating high above the others, able to look down and see his own body running on the jungle floor, dodging the slow blue bullets of the NVA, doing exactly what he told it to do.

He could see the NVA, the blue uniforms on the blue earth, and he took them out one by one.

When it was over, he was covered with blood. He could not remember why. He could not remember how he had killed them, only that he had, their fire meaningless, their weapons—one by one—stopping at last.

Carruthers, the black operations sergeant, was the first to reach him. "Jesus, boy, that was some down-home shit kicking," he said, but the look in his eyes said something else. The black man wouldn't touch him. He'd never seen anything like it in his life—a boy fresh from Fort Bragg moving through jungle like that, untouched, ten NVA kills. The black man wouldn't touch him.

When he returned to camp, he heard how she had died. The camp had been mortared again, but this time a longhouse had been hit. Three villagers had been in it, the girl one of them. She had been wounded in the spine and they had packed her with plasma. She had asked for him until she died.

He looked at her body. He thought he should take her hend.

Three nights later he dreamed of the leper he had seen on a beach near Da Nang. The hideous skin, the beautiful sand, a colony the war never seemed to touch.

In the dream the leper wore his face and said, *You can save yourself with this thing, Danny Boy, but you can't save others. What is it worth? What is it worth if you can't save another?*

Later, standing down in Pleiku, he would remember what it had been like.

The ninth blue animal was climbing down from the tree, trying to flee, when he saw it from where he floated high in the trees and told his body where to go and caught it before it could get away. He danced toward it, avoiding the little pieces of metal it threw at him, and tore its throat out with a knife. He knew this was wrong, that the others would be bothered, would look at him oddly, so he fired into the animal's head, making a third blue eye there, and held the body up against him as it died. Then he went to find the tenth.

April 17, 1990. When Gala suggested a picnic with the Moynehans that weekend, he said yes. The park was full of kids, the ducks so well fed they could barely walk and wouldn't even look at the bread in your hand. He wanted his son to lie on the grass with him, but he knew he couldn't keep him for long. The Moynahan kids knew how to have fun.

God, I love that boy, he would remember thinking.

They were lying on the grass, the two of them, near a hedge of bamboo. They could hear the children playing in it. When the dark-skinned boy appeared out of the cane, holding a black toy rifle, he tried to smile. The boy stopped, raised the barrel, and stared back at him. The barrel came down in a flash and the muzzle snickered. Beside him on the grass Aaron's head exploded, the bottom jaw remaining, jutting like half a Halloween grin, teeth glittering with the blood, as the body spasmed, spasmed again, and tipped back slowly in the reeds and shallow water, which smelled like spoiled milk.

"Aaron!" he screamed, the weapon in his own hands arching, stitching the boy up the middle with a burst. Somewhere out in the paddy two women began to scream.

Aaron was staring at him. He was okay now. There wasn't any blood.

Gala was rushing toward them.

"It's all right," he told her. "It's all right."

He looked at the boy standing by the bamboo. The barrel was pointed at the grass now, a duck passing inches from it. The boy was watching the duck now.

The boy's eyes weren't even slitted. There wasn't even an epicanthic fold. The boy was Hispanic, Chicano, that was all.

This isn't real, he told himself. *This is a disease. The others have it, too.*

What is it worth, the leper said to him on a beach as blue as his wife's eyes, in a war that hadn't ended, *if you can't save others? What is it worth, Ni Fa?*

October 18, 1964 They were just kids, he and Art. Jesus, they were just kids. They were going to get out of the heat of the Merced Valley, away from the same girls with the same brown hair at the same county fairs, away from the jobs you always took after graduation and the little towns where no one knew a damn thing. They were going to get away and then come back, older and better. They were going to be John Kennedy's warriors—berets and three languages and training in five combat arts. They didn't smoke. They drank in moderation. They ran fifteen miles a day together, did ten sets of everything and laps at the school pool whenever they could and watched their grades. They didn't want you if you flunked out. You had to be smart. He'd miss his sister and his parents, sure, and even his brother, Jim. He'd remember his father standing in the almond groves setting the long sprinklers that seemed to go forever. His father would stand up suddenly in his memory, in the morning light, and wave at him, and he'd remember this, carrying it with him in any jungle, on any highland plateau, in any riverine darkness. He'd remember his sister, too, her last birthday party, and his mother, her eyes. He'd come back *to* them all at last, older and wiser. He knew this.

April 17, 1990 That night he saw two men from his unit die horrible deaths, their blue bodies headless, cleaved from their spines by men they thought were friends in a war that wasn't a dream at all.

He awoke shouting, and it took him a moment to realize that someone else was screaming with him.

"Stop it! Stop it!" Gala was kneeling on the floor, as if in prayer, fists clenched like a little girl's, the anger and fear whipping her face like wind, her eyes wide and locked on him, but not in love. She said she didn't want this anymore, that it wasn't fair to ask her to live through it again and again, and that if he loved her he wouldn't.

Tomorrow, he knew, he would find her at Jack's house. Aaron and Katie might or might not be with her. She could stop pretending now.

Was it gone forever? Was it buried so deeply after twenty years of his life that it would take a hundred deaths witnessed, a hundred threats to his own body to bring it back, to make him again what he had once been, moving through jungles untouched, unafraid, floating free, the world turning blue, the gift—as Schuermann had put it more than once—waking at last after an eon of civilized sleep?

He remembered a man in Pleiku, an A-camp captain from Georgia who hadn't been afraid of him, who'd known the blue flickering for what it was, because things like this happened to him too, and he knew of others just like them, and he kept a list.

"It's a warrior's gift, Danny Boy," the man had told him. "*Ken tai*. Samurai's blessing. Use it or lose it, Danny Boy."

But this wasn't a warrior's war, the man had said later. MACV wasn't going to let them win. So it made no sense to stay, and he'd left as soon as he could.

On a pretty campus after the war they had met again, invited by an agency that had kept its own list. They'd worked together there, laughing and questioning, for a couple of months, and then gone their separate ways.

Later, that man—whose name was Burdick—had tried to find him more than once. "We can use this thing, Danny Boy," he'd said on the phone, his voice the soldier he would always be, looking for a war to win. "We can change the world with it. I'm putting together a little group—in Schuermann's memory. You know them all. I hope you'll join us." He'd paused, then added, "We don't need *their* army, do we, Danny Boy?"

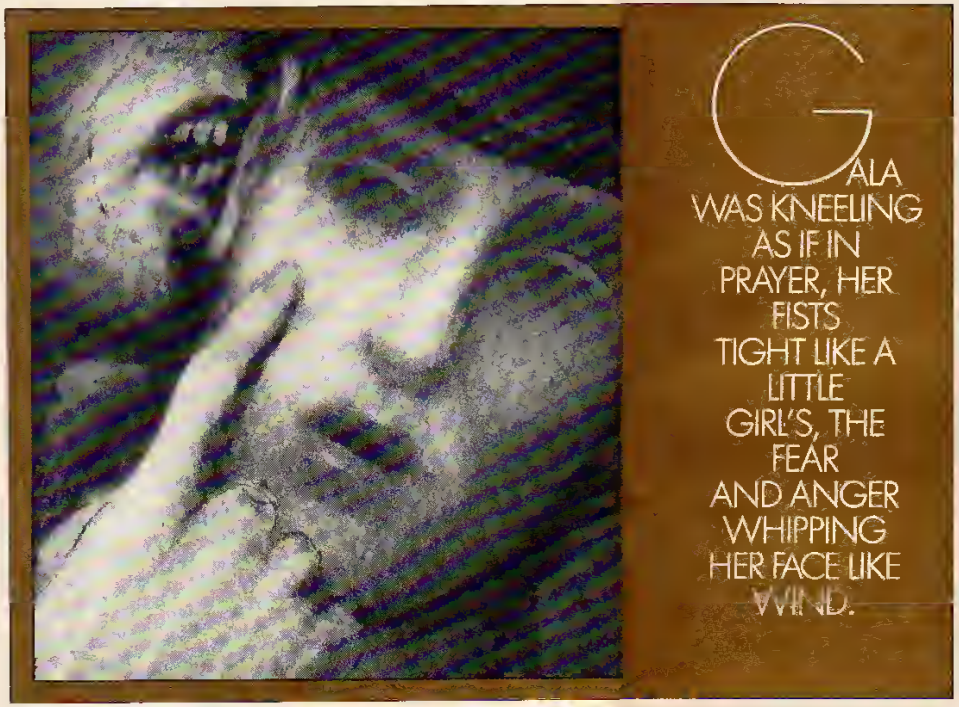
He'd told the man *no* both times.

He found where they lived and watched them come and go. A young man who held his cigarette the way Europeans do and wore a white short-sleeve shirt watered the front lawn every day. An old woman in a black *min dai* walked up and down the street every morning with a two-year-old. The four boys who attended the high school walked home at four PM and did not leave again. Stone dogs with heavy scowls sat on either side of the old porch, and he could see the unpainted lumber of the rooms that had been added, one by one, to the back of the house. He watched a yellow Celica arrive one day and a pretty woman with Eurasian features get out. She did not live there, he would discover, but she visited often.

Three weeks later he found the courage to speak to her. She did not understand him at first, was annoyed, and did not want to talk. She worked for an agency that resettled her people, she said at last.

These were her cousins. They had lived in Cholon, too.

He followed her and made sure that he ran into her again, at the place downtown where she usually had a late lunch. A week after that, he asked her out. He did not tell her he had fought there, but she seemed to know. There would have been no other reason for him to talk to her, would there?



GALA WAS KNEELING AS IF IN PRAYER, HER FISTS TIGHT LIKE A LITTLE GIRL'S, THE FEAR AND ANGER WHIPPING HER FACE LIKE WIND.

January 3, 1967 *When she opened the door, he was standing there, shaking and filthy. His eyes were dead. "You have killed," she said, her accent a whore's, her broad face beautiful.*

He said,' "Yes. But my hands are empty now."

She took him by the hand, led him to the small tiled room with its vase of white chrysanthemums, and made his bath warm. She helped him from his uniform and saw the old blood on it. As she bathed him, he began to fall asleep. She kissed him and let him lie back with his head against the tile. He did not come to her as the others did. He came as a child, running from someone else's shame. This was why she felt what she felt for him, and why she thought of him when he was gone.

She knelt for a moment by the window, looking out at Cholon, at Dong Khanh Boulevard and the lights of Saigon, and in the darkness above the city tried to see the flight of a beaked bird or the flailing of a big cat, fighting for its eternal life.

He did not wake, even when she moved him to the bed. There, she wrapped her legs around him until he was warm against her, and stared into the night until she could see it.

June 18, 1990 Over dinner, the fifth time they went out, he said to her, "I knew a man named Clipper—a medic. For nine months he saw people, his and yours, whose deaths made no sense to him. When his tour was over he went to Japan. I wanted so much to go with him. I knew it was the right thing to do. He went to Kyoto, to study kendo. By the end of three years he could hear men approach him from behind even when they made no sound. He knew when the katana would fall on his shoulder in the training even when there was no warning, except the truth of his own centeredness, the rightness of his choices. The bodies of small boned people falling from the skies, pushed by men just like him, were still with him, but they meant something else now. He said this in a letter, one that did not sound like him, one he had written only because he had promised he would. It was the only one he wrote. I read it again and again in Ben Biet when the shelling wouldn't stop, when the world stayed blue for three days and I was still alive, and there were others who were not. I wanted to be there with him. I wanted to use what I had differently. Over the next two days I lost the letter. I cursed him for leaving. I told myself that he was a coward and didn't care that others might die in his place."

She looked at him. He could not read her face but did not think it was contempt he saw. She had been there, too. A secretary for a shipping company, she had said—

It was the first time he had talked to her about these things. After this, it would be at her apartment, only there, that he would tell her.

April 17, 1969 "Synchronicity," Dr. Schuermann was saying to the ten of them, "is a wonderful idea. It is a Jungian concept that explains, without really explaining, psi phenomena that are beyond even speculative explanation. But it doesn't help us much, does it?"

The group had been together for four months, working in the lab and on the makeshift training course six days a week, twelve or fifteen hours a day, and they liked this Schuermann, candy-assed civilian that he was. They liked him and he liked them. He liked seeing them think, and even the lamest training idea someone suggested he would try. Even Burdick, who had quit the war because of MACV, liked him, and this said something, didn't it?

"The trick," Schuermann would say, "is not to understand the role of the hypothalamus or medulla oblongata, or the importance of 'intentionality readiness peaks,' or the phenomena of 'psi missing,' but simply to find a trigger—*here*, back in the Big PX—that will work as well as fatigue and blood and fear worked over there, to make you what you were. After all, boys, there are a lot of people interested in what you were *over there*."

Their visitors from Virginia didn't come often, and when they did, they talked to Schuermann, no one else, and this made it easier, as did the pay, and how laid-back it all was, because Schuermann wanted it that way. All they had to do was listen to what terms like *OBE* and *waking precog* and *nocturnal chair* meant, sit at a monitor with wires on their chest and head every once in a while, and do their best to bring it all back: the voices, the tunnels of light, the visions of angels, the auras, the gut senses, the blue flickering world—the things that had kept them alive, over there. "They don't think we can do it," Schuermann would say. "They think we need a war to bring it back, boys. What do *you* think? A little fatigue, a little Valium, an arcade game or two? We can do it, can't we?" He'd wait, and then, with a wink, he'd say, "If we can, *let's not tell them*."

He'd laugh. They'd laugh. They were twenty-two years old and thirty and forty-five, and he was sixty-five, the retired director of a "dream lab" on the East Coast. They'd all laugh like boys.

The campus was beautiful. They were civilians now, vets with special talents and special invitations to be here, and it was like a dream.

"Psi cannot exist independent of individual psychodynamic need," Schuermann would say while they gazed out the windows of the classroom, the eucalyptus trees dappling the sunlight, the girls walking by pretty as magazine ads, books under their arms. It didn't bother him. He knew they needed this, and he would say it again without getting angry. "When a woman dreams her lover is dying, and he is, it is a bond-based receptivity ruled not by the paraphysical laws of the talent itself but by her own, very measurable psychological needs. Sometimes the imagery is literal, sometimes it is symbolic, but it is always dictated by *need*.

"When the world turned blue, as it did for you, Daniel, it was because a part of you, refusing death, reached out. When you, Burdick, made the NVA see the pictures you wanted them to see, just like your father did in another war, it was the same. Had you been able to accept death—your father's or your own—you wouldn't have needed pictures, would you.

"What is it that a man *really* needs, boys?" Schuermann would ask them, his voice rising with emotion. "Is it victory over death, power over others, the sating of every hunger? Or is it—sometimes—something else entirely?"

They didn't have an answer, but he would ask it again and again.

It was there that they heard of the second group—run by the agency on a base somewhere. DOD and need-to-know, its members still in the service and training hard as dogs. They laughed at how *serious* it all sounded.

Two months later, as they began to find the trigger, Schuermann died in an car accident near Napa and they were told to leave.

June 22, 1990. Jack Tatum didn't panic when he first felt the pressure on his face. He was dreaming of Santa Barbara, of his first wife, and the pressure, when it started, was faint. Then he began to suffocate. In the dream he had fallen into the Pacific by their hotel, couldn't get air through his nose and had to open his mouth wide.

But the pressure was real.

When the cloth was plunged deep into his throat, all the way down to his larynx, and he began to gag, he came fully awake but was unable to make a sound. A single hand held both of his in excruciating pain, and he could feel two fingers touching the cartilage of his throat as if lovingly. The figure standing in the darkness above him held him, and he knew he wouldn't be able to reach the handgun by the bed.

It had taken less than four seconds, he would realize later. The pinched nose, mouth springing open, the rag crammed down his throat, the pressure points on his hands, the clear meaning of the fingers at his throat. These were the kinds of things they taught you in special-warfare schools. The kinds of things he knew nothing about.

The figure in the darkness waited.

There was enough light through the window that he could see the basic contours of the face.

He knew that face. Was it possible?

Yes. He knew this man's wife. He knew this man's children. He had been hoping for an affair, something long and convenient for them both. They'd had lunch twice. He'd kissed her in the car two days ago.

He'd never imagined the man would do anything like this.

The darkness shifted. The figure stepped back and turned, as if waiting for him to do something.

He got the .38 from the drawer quickly, fumbled, and was aiming it, aiming it again, into the darkness.

Still the figure did not move.

He held the gun tightly, wanting so much to fire it, but unable to.

When he was alone again, the pain fading from his hands at last, he saw suddenly what was expected of him, how he could not afford to open his door to that woman again.

There had been no blue.

None at all. Even when he'd waited for Tatum to fire the weapon, there had been no blue. The talent was dead and gone. He knew this now.

When he appeared at her door that night, he could not remember driving there. "What is it?" she said. Her English was good.

She was a strong woman. He had known her long enough now that her concern was probably real, that it might even be love, the feelings they felt.

He could not say it.

"You have killed," she said.

"In my dreams," he said. "Only there."

She let him in, taking him by the hand. It was not the first time he had come to her this way, but it was the worst. He had tried to bring it back, and there was nothing, nothing at all. It was another country, another time now.

In the small living room with its vase of white flowers she kissed him, knelt down before him, the ao *dai* hugging her like a silky hand, unbuttoning his shirt, pulling it up and away from his belt. Then her head moved and there was a coolness against his chest. A kiss. A single kiss.

He felt nothing. His mouth, his eyes, and his lips were dry.

He was lying back, his head on a familiar pillow, his eyes on the ceiling, which moved slowly, turning like the fans in dark rooms where old men smoked opium and dreamed of animals they had never seen.

He could hear the rustle of silk, the whisper of it drifting to the floor like dry leaves, and then she was beside him again, working with the clothes that remained.

He looked at her, and a cry came from him, below all dryness and death.

She was naked, kneeling as if praying over him, her hair untied, covering her shoulders, and the whites of her eyes like crescent moons, like chalices filling with moonlight. Her breasts moved gently as she worked, unembarrassed and unafraid, and the jackknife curves of her legs, her skin the color of teak, the feet upturned in another prayer, were a beauty he had not seen in years. He closed his eyes. He could feel her fingers. He could feel the cloth slipping away as she helped him do what he could not do.

He felt nothing but this.

And then he heard her gasp.

He raised himself up and found her staring at him, at his groin, at the exquisite tiger there. She had never seen it before, he realized, even after so many nights. "I'm sorry," he said.

She was nearly crying.

"It was done years ago," he said. "Over there."

There was nothing he could say to change it. It was her world there, just inside the jut of the bone. The hope of a city, a country. He hadn't even known what picture it would be when they'd found the place on Tu Do Street, and, too drunk to say *no*, he had it done.

THE BODIES OF SMALL-BONED PEOPLE FALLING FROM THE SKIES, PUSHED BY MEN JUST LIKE HIMSELF, WERE STILL WITH HIM.

He moved his hand to her side and touched her. She shivered. He kept his hand against her. In the end she touched him there as well.

When he awoke she was asleep beside him, naked, her body against his as if she had known him her entire life.

On the nightstand he could see the white flowers.

June 23, 1990. He had a dream like no dream he had ever dreamed. In it he could see an inconspicuous military base, one he had never visited but somehow knew. The kind where white-gloved guards snapped off crisp salutes to official visitors and were courteous to civilians lost on the interstates. The kind where insects beat themselves to death against the lights of the guardhouse during hot summer nights.

He could see a compound. It was in the northeast corner of the base, just beyond a small airfield with its own road access and gate, its own guards in maroon berets. Its ten-foot chain-link fence had double outriggers with three strands of wire each and was electrified. Inside the fence was a helicopter pad, and on this the twelve men in training here came and went, as did their superior officers, as did those who had trained them for fifteen years.

He was not one of the twelve, but he somehow knew them—name by name, rank by rank, talent by talent—and he was with them in the briefing room now. They were the government's team. The team that had trained like dogs. They could hear the rotors. Was the colonel, or the man in civvies who had accompanied him, coming back? Had there been a change in mission plans already, only an hour after the briefing? Would the night insertion into a destabilized Lima be called off?

Something was wrong.

Jasper Cheek, the Special Forces sergeant hardened by countless SOG missions in Laos and Cambodia, and a "waking precog," was sitting, holding his head in his hands, his head moving from side to side, unable to get up. Adam Riggs, the Navy SEAL sergeant who saw auras on those about to die, was up and standing, pale as a sheet, trying to speak, though the words would not come.

He was, the dreamer saw, crying.

The rotors were wrong—the pitch of a lighter machine.

What was happening?

Lieutenant Yamura was up now, too, eyes as wide as a child's, moving slowly toward the front of the room where the general and the civilian had stood, staring through the wall. Wernick, the Air Force Black Beret, and ASA's Arias—the one who had said, "I know I'm the one doing it, Captain, but when it happens I feel like a puppet, you know, the strings, someone else doing the pulling"—were looking through the ceiling as if they could see beyond it, to something horrible there. The veins in their necks were gorged and pounding.

What was it? Had they been poi-

soned? A test? A hallucinogen in the ventilation system? Each was a talent, a survivor with special training. Looking at them now it was as if—

Edwin Vick, a "remoter," and the only talent the agency had found among its own screamed suddenly, *"Mother of God! Where are the weapons?"*

Four of them—led by Nuno another remoter, and the nocturnal clairvoyant Sebastian—came awake now, heading for the door. As they reached it the sounds of automatic weapon fire began. There were sound suppressors, but it didn't really matter.

Suddenly the dreamer understood. They were going to die. Someone was going to kill them because of what they were, because of something their superiors in Virginia had done long ago and because of what they were trained to do. And it would be someone who could indeed do it, who was as good as they were and always had been—the gut senses, the auras, the OBEs, the remote viewing, and everything else a war had wakened in them.

They were going to die and they could see it.

They could see themselves dying.

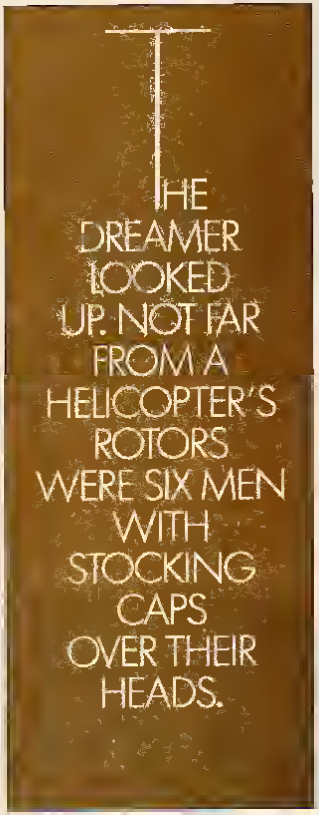
They were outside now, all except Riggs, who was still in his chair, the vision in his head—the future minutes or seconds away—holding him there. He could not stop crying.

The dreamer moved toward the door, and as he did he heard the silenced Ingram machine pistols outside again and watched as the forty-five-caliber slugs tore through the thin walls beside him. He kept moving. The world was not yet blue. Outside a body rolled against his legs. Bert Northcutt, the Special Forces sergeant from Bluelight. A sound came from the man, then stopped. Under the light—where the insects battered themselves to death—he could see the exit wound, where it had taken his windpipe out.

The dreamer looked up, and there not far from the blurring rotors of a lightweight helicopter painted the colors of a hospital medevac, were six men with black stocking caps pulled over their heads, the eyes cut out like jack-o'-lanterns. They hadn't seen him yet. He saw the frogman Chambers on the ground. The quiet, sinewy man who spoke of his talent as "Cousteau vision," where 'everything down there is as clear as a TV set,' was trying to get to his feet. Something about the man's shoulder was wrong, wet like an oily rag. A jack-o'-lantern face appeared around the corner of the building, raised the Ingram, and sprayed. Chambers jumped sideways, but it was as if the Ingram knew where he would be. It made no difference. It happened fifty or sixty feet away, but the dreamer saw the three heavy-caliber slugs strike the man's skull and the back of his head blossom like flowers, filling the night air with rain.

The dreamer moved toward the helicopter, wondering how he would die.

Off in the shadows of the Q Building he saw a man dodge, dodge and



dodge again as the rounds from two Ingrams tried to find him. The man's talent was working and he was good, moving as if on a ball court. He was trying his best. He did not want to die either. The man had something—a length of wood or metal—in his hands and was nearly to the first jack-o'-lantern face. He was raising it, whatever it was—

Before he could swing, the jack-o'-lantern dropped the Ingram and stood waiting. The man swung, but the jack-o'-lantern had already dodged with a terrible ease. The man swung again. The jack-o'-lantern tilted to the side, and a leg came out of nowhere and caught the man in the face. The man shook his head, swung again, knew where the other would be this time, but the other knew it, too, knew it *better*, as if guiding the man where he wanted him to be. As the man swung, his talent helping him, the jack-o'-lantern turned three hundred sixty degrees, then one hundred eighty, feinted and kicked, and though the man had seen it all and was already moving, too, the jack-o'-lantern had seen more, had already kicked again, and the dodge brought the man's neck right to him. The neck snapped. Someone laughed somewhere. The jack-o'-lantern stared at the body for a moment, grinning, then turned. He looked at the dreamer and began to walk toward him.

A name floated up from the darkness, which still held no blue.

Burdick.

The jack-o'-lantern face came toward him, and it was the leper now, and it wore his face. "They killed Schuermann, Danny Boy, because he wouldn't help them." Burdick said at last. 'He had the trigger' and he wouldn't help them. You didn't know that, did you? You should have joined us. We could have worked together to avenge him.' The face paused. "We still can, Danny Boy. We're the only team left now." The face paused again. "The gift isn't dead, Danny Boy. It *never* dies." All of this was real, the dreamer knew. Twelve men with *talent* had died, were dying, this very night somewhere, while he was living.

The dreamer felt something stir beside him and knew what it was. In another world, a woman lay on a bed beside him, dark-skinned, and asleep. He remembered the little girl who had died in Dak Lo, and the woman lying against him now, what he might feel for her if given a chance, and the man named Burdick, who had reached him at last, in his sleep, in his waking hours, picture after picture over the past two months, without his knowing it.

It never dies, Danny Boy, the jack-o'-lantern face said again, and waited.

There would be a phone call or letter soon. The man named Burdick would want an answer.

Ni Fa? he heard her say beside him, her hand in his, as alive and real as anything he had ever known.

He felt her stir again, and as they woke together, he knew the two he could save. DO

CAVE DWELLER

CONTINUED FROM PAGE 57

that my cave is the only reality. I didn't feel anxiety or sorrow.

Omni: What physical adjustments did you immediately go through?

Follini: During my first days in the cave, I felt very tired and often dizzy. Now I feel fine, even if I'm not perfectly in training in the judo way. [her peak—Follini has earned a brown belt in judo] But I am lazy. I practice *do-in* [a physical training program]. What physical activity I can do, I do, even if I have to pull my ears to overcome my laziness.

Omni: Did you go through any mental stages or adjustments?

Follini: After I entered the cave, I became afraid of the possible dangers of my surroundings. The fear became so great that I became identified with it, so much that I lost sight of it. [Translator: She's having great difficulty expressing herself. The fear was so much a part of her, she seems to be saying, she was lost in it.]

My house is on top of a landslide, I thought. Looking at the stones—who knows when they tumbled down from the top of the cave? I imagined the noise they created. I really believed that the cave was an invader and would crush me, punish me for my arrogance. Now I feel more satisfied, more serene. I feel like I've let down some barriers, anxiety, fears, sterile angers [*rabia sterili*—an odd, unfamiliar expression, says the translator]. But now I know this is my own world. It cannot scare me any longer.

Omni: Will your cave experience help you overcome personal problems?

Follini: At a personal level, I am trying to collect my strength, correct my attitude, to renounce [*atteggiamenti rinunciatari*—the phrase doesn't exist in Italian. Possible meaning: to withdraw from the problems], and establish positive relationships with people, without allowing any abuse and without allowing any crimes to be perpetrated. [Translator: Grammar is really off-the-wall.]

Omni: Isn't it contradictory to come to grips with your problems by withdrawing and renouncing? Are you running away from life?

Follini: My time in the cave will not solve all my problems. It's a question of perspective. From here, I look at the world very differently. This change of perspective may help me find different solutions. I am convinced that if you don't learn to know and love yourself, you cannot know and love others. Probably for this task, a few months are not enough.

Omni: How much time do you spend in the module and how much time do you spend outside in the open area?

Follini: Very little time in the open cave. Even less in the module. I am almost always traveling around the world: Brazil, England, China, Italy. Actually, I spend a great deal of time in the module, reading or playing the guitar. I go outside the module only to empty the toilet. When I'm out there, I cook and contemplate the sky! [She laughs.] I also take food to my friends, Giuseppe and Ninetta [two enterprising mice that showed up in the cave and befriended Follini].

Omni: When you picture the outside world, what do you see?

Follini: Images, memories and fantasies alternate. Two images are beautiful: the last sunrise and the last sunset. When I return to the world, I hope to see a lot of smiling people.

Omni: Have your impressions of the cave changed since you first entered?

Follini: It's more beautiful. It's a lot colder.

Omni: Does it seem bigger or smaller?

Follini: I haven't noticed any change. It is "more known."

Omni: NASA has considered making space station areas adjustable so crew members may rearrange their living spaces. Is that a good idea?

Follini: As an interior designer, I would first like to see the project. For sure, it's a good idea to provide different spaces for various activities.

Omni: Do you prefer your module or the environment outside the module?

Follini: [She becomes angry.] When I sit down, wrapped in thought, I look at the rocks one by one. What do you really want me to say?

Omni: When you first entered the module, how did you arrange the space?

Follini: First I divided the space into the living room, bedroom and dining room. I set down mats where I eat, sleep and read. The mats are very comfortable.

Omni: What books have you read? [She goes into such detail that the crew begins to joke about her response as the *revisita*—the book review journal.]

Follini: My favorite book is the *Dictionary of the Italian Language.* I've read *The Gates of Grace* by Evelina Chao. I especially liked *The Black Opera* by Marguerite Yourcenar. I reread, with pleasure, *The*

CREDITS

Page 10 clockwise from left, Pete Turner; John Stuart; Brad Holland; Jeff Rotman; David Doubilet; John Stuart; **page 18,** Arnie Adler; **page 20,** Kim Poor 1982; **page 22,** George Pappas; Ph.D.; **page 26,** © Joe McDonald/Bruce Coleman; **page 28,** Steven Hunt; **page 30,** Henner Prefi; **page 34 top,** M. E. Warren 1972/Photo Researchers; **page 34 bottom,** Ted Horowitz/The Stock Market; **page 35 top,** James Pozarik/Gamma-Liaison; **page 35 bottom,** Roy Morsch 1984/The Stock Market; **page 36 top right,** René Lynx; **page 36 bottom,** NASA; **page 37 top,** The Stock Market; **page 37 bottom,** Mario Ruiz; **page 38 top,** Photo Researchers; **page 38 bottom,** Movie Still Archives; **page 39,** G. Roland Lusing/Photo Researchers; **page 40,** courtesy of Bellcore; **page 88 clockwise from top left,** John Zolner; Bob Kristofik/Image Bank; Don Landwehrle/Image Bank; Blink; Tom King/Image Bank; **page 78,** Ian Lloyd/Image Bank; **page 88,** Tim White; **page 90 top right,** Ralph C. Eagle, M.D./Science Source/Photo Researchers; **page 90 bottom,** Movie Still Archives; **page 91 top,** The Bettmann Archive; **page 91 bottom,** The Bettmann Film Archive; **page 92,** Movie Still Archives; © 1957 Universal Pictures Company, Inc.; **page 120,** © 1966 W. A. Elliott Co.; **page 121 top,** Shigeo Takagi; **page 121 bottom,** © Lockheed Advanced Marine Systems, San Diego; **page 122,** © Mindscape, Inc.; **page 124 top,** John Stuart; **page 124 bottom left,** Intramark Incorporated; **page 124 bottom right,** The Isokinetic Recumbent Exercise Bike; **page 125,** Ken Duncan, Ltd.; © 1987/Spektis Photography.

Name of the Rose by Umberto Eco I let myself go with two fairy tales by Michael Ende entitled *MOMO* and *The Neverending Story* I became very involved in reading *Dona Flor and Her Two Husbands* by Jorge Amado I had some difficulties with *Favorite Fairy Tales Told Around the World* selected by Virginia Haviland I just started *Dynasty* by Eileen Lottman Naturally, I keep M Siffre and Maurizio Montalbini's books about cave exploration close at hand [Follini gets up and looks for book titles She can't remember them Montalbini commented that Follini's concentration was poor and she may have been experiencing mental drift a common occurrence among Antarctic explorers]

Omni For a person in your situation in a cave does *Dona Flor* have too many references to sex?

Follini The use makes the organ I do not know When a function is not necessary it becomes temporarily suspended—like turning off a light in an empty room I must tell you I don't feel tormented by the lack of sex, so I didn't find the references in *Dona Flor* excessive

Omni Astronauts in space often turn off the spacecraft cameras because they feel as if they are being watched all the time Do the cameras bother you or give you a sense of security?

Follini Well you know a star like me I'm used to it! You may keep my physical presence under surveillance but the camera can't enter my mind In the beginning it was a bit intrusive a prying eye and I was afraid of acting unseemly But the feeling disappeared Now I don't care

Omni Do you look at yourself in the bathroom mirror?

Follini Not really except when I put on the electrodes for the EEG experiment I glance at myself when I wake up to see if I recognize myself

Omni Do you recognize yourself?

Follini Well, I don't know I haven't got used to the idea of having a face or precisely this face

Omni If Montalbini extended the experiment for a longer period of time how would you feel?

Follini [She chews on her fingers rubs her neck, thinks a long time grabs some food laughs] I do not have the vaguest idea Probably it wouldn't make any difference since this is my life It would be an extension of the eternal moment that I now experience This is not good or bad It would depend on how I gave it polarity—turning something neutral into something positive or negative

Omni Does the knowledge that you will come back to the world—full of life full of activity full of light—psychologically sustain you?

Follini Even here there is life My return will be a change and I enjoy changes, but I do not think about my coming out as a "freeing" [The crew aboveground reacted emotionally to this answer—tears welled up in translator Fraschini's eyes Follini had courageously rejected the idea that the cave was lifeless in spite of the stone surroundings]

Omni If people went on interplanetary voyages that lasted for years and there was no certainty of returning to Earth again what mental adjustments would they have to make?

Follini [She took a full tour and a half minutes to answer] They would need to develop a flexible attitude that included the possibility of not returning to Earth Probably they should be paradoxically free—free from tears and desires

Omni I've been told by many explorers that their sleep patterns changed during their journey into isolation Has that happened to you?

Follini I have the impression that I am sleeping a lot but this is normal for me I sleep well I sleep frequently

Omni Are your dreams more or less vivid since you entered the cave?

Follini They are more vivid At the same time I think I am dreaming less I've dreamed three times that I left the cave before the end of the experiment In one dream I had to start over, from the beginning I dreamed more than once about my parents Along with a cousin of mine they were coming here The most beautiful dream was about a man Nothing scandalous He shook my hand smiled at me and then we joined some people to drink a glass of wine

Omni Have you seen Lucy the prehistoric woman you dreamed about before you went into the cave?

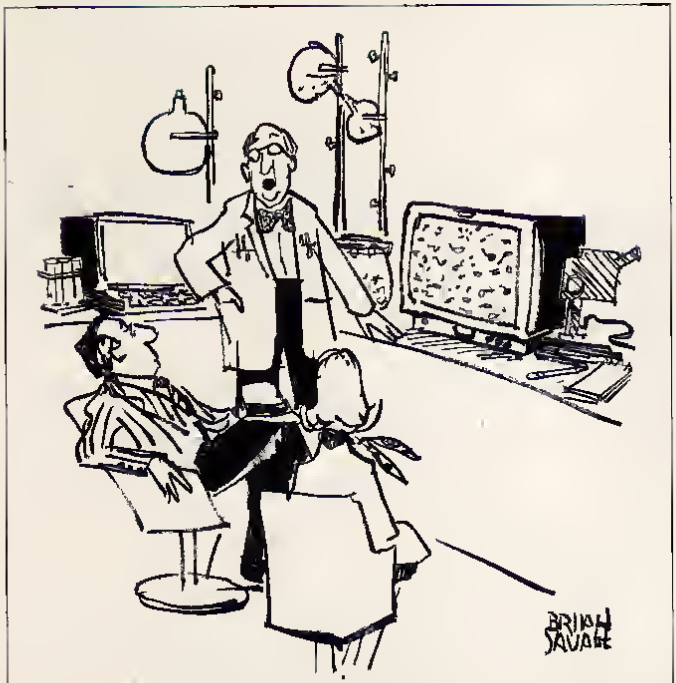
Follini No I haven't seen Lucy

Omni: Why hasn't she visited you?
Follini: Perhaps I became Lucy. I do not know. I also don't understand why I'm dreaming less or why I don't remember my dreams. I feel a little sorry.
Omni: In various experiments in the Antarctic, the subjects couldn't tell the difference between dreaming life and waking life. Have you experienced this?
Follini: No. Clearly, I can separate dream from reality. But in this situation of atemporality, it's the reality that may seem like a dream. It's very difficult for me to remember if I did something an hour ago or a month ago.
Omni: Do you follow a daily routine?
Follini: I try to discipline myself, probably you've noticed. As soon as I wake up I take the medical data, my blood pressure and urinalysis. I transcribe the data and communicate it to the crew. Then I prepare tea with yeast, do the salute-to-the-sun exercise, which stretches my muscles. After a while, I have breakfast, read, play a card game or the guitar, draw a little. I cook lunch, and exercise again. After lunch, I read and take a nap. When I wake up I do judo or T'ai Chi Ch'uan. After supper, I read and go to bed. At intervals, I take medical tests and answer calls from the crew.
Omni: You said you wanted to use the time in the cave to reevaluate your relationships. Have you done that?
Follini: Yes. Yes. I am reevaluating my relationships with everyone I know, even the ones I just met. Generally, I feel more open and clear toward them.
Omni: Have your thoughts changed about any people, for example, your mother and father?
Follini: [She gets up and leaves the terminal to go to the bathroom. She returns seven minutes later.] I've learned that I love them very much, more than I thought.
Omni: Have you considered whether you'd like to remain single or get married and have children?
Follini: Since I've been in the cave, I've married a couple of times and had two children. But I was unfaithful. I was weaving while a girl was doing homework and a man was closing a poultry pen. Perhaps I would like to be normal, to have a husband and children. But I cannot see myself in this role. I will keep thinking about my options.
Omni: In the absence of relationships or distractions, what fills the social void?
Follini: I try not to lose my concentration, but to keep concentrating. I still have a lot to learn. Sometimes I try to identify myself in a stone, another person, or an animal. I think about the mathematical harmony of the world. I remember with extreme clarity what I've thought about, buried, or denied in the last five years. I reevaluate small details until they become important. I'm surprised at my narrow-mindedness. I remember every surrender, every failure, every blow—"Whoever becomes a sheep, the wolf will eat." I relive my memories with tactile, olfactory and visual sensations. I feel happiness, pain, serenity—intensely.
Omni: NASA structures the astronauts' time very rigidly. Is that a good idea?
Follini: No. I don't think so. You cannot control biological and mental rhythms. I think it's better to face the situation with flexibility or, if you prefer, with fantasy.
Omni: Do you miss knowing what time it is, what season it is? Do you miss the rhythm that time gives to life?
Follini: Here, I am the tyrant of time. I decide what time it is so I can create my own day. And I have time for everything I want to accomplish. It's not important what time it is outside because I have my own seasons. Even if it is a sunny day, I cannot see it, so it's not important to me.
Omni: Do you think that time and light are essential to the human race? Do you think we could live without them?
Follini: The light is vital. Time is a good thing if only we would not try to make money, as the proverb goes. We are the mistaken ones, not the rhythms of nature.
Omni: Is solitude a good teacher, a unique teacher? Or does loneliness distract from the search for wisdom?
Follini: Solitude needs a couple of assistants: willpower and self-discipline.

The first interview ended at this point. It was one in the morning, March 8, 1989. The interview had lasted seven and a half hours. When Follini was queried, she thought only one hour had elapsed. She ignored the cues of fatigue from her body, such as frequently rubbing her back. At one point she had a snack, munching on dried apricots as she typed out the answers to my questions.

Before the second interview Follini was told that *un gruppo* had arrived to interview her—presumably a group of journalists or psychologists. This interview took place Thursday morning, March 9, at 6:30, just after sunrise. It lasted until ten in the morning. After sleeping for 14 hours, she was cheerful, laughed a lot, and gestured often. Her crisp answers reflect her mood; her response time was quicker than in the first interview.

Omni: Do you spend much time gardening? Do the few living things down there—plants, frogs—give you comfort?
Follini: I don't exactly garden. I have a sprout container in which I cultivate wheat and watercress. I haven't seen the frogs yet. They're probably shy. I met the mice. We've established a neighborly position with each other. I fill up a plate with water so they can swim. But I leave them alone. I don't try to catch them or be intrusive in any way. They show some trust, allowing me to get close to them, up to a certain point. But they don't comfort me. Frequently, I see cave spiders and I offer them a snack.



"In a minute we'll have the results of your sperm count, but first, an important message from your AMA."

AT $9.47, LONGEVITY ANSWERS THE QUESTION: WHAT PRICE IMMORTALITY?

A year's subscription to Longevity has to rank as the deal of a lifetime. Because for the Charter subscription price of only $9.47 you get 12 issues of the first magazine devoted to helping you live longer and better.

That's just 79¢ an issue. 74% off the cover price of $36. Which isn't bad, even if immortality isn't quite within our grasp. Yet.

In the months to come, there will be articles on subjects ranging from exercise to nutrition to psychology and genetic engineering. Provocative stories from the frontiers of the field and immediately useful, practical advice, written in a fast-read style.

It's an ambitious goal, but one we doubt you will find hard to subscribe to, especially when just $9.47 brings you your first 12 issues.

But act now. Because at least for the time being, none of us are getting any younger.

ARTICLES THAT ADD LONGEVITY:

- **The Only Fountain of Youth**—Jane Brody, best-selling author and health columnist shares the best solution to those seeking to stay young.
- **The Longevity Diet**—Our nutritional plan to help you beat the major killer diseases.
- **268 Common Drugs That Can Make You Look Older**—Your medicine cabinet may be hazardous to your looks.
- **Good News About Meat**—Researchers say that it's not as bad as we thought—and it might even be good for us!
- **No-Surgery Face-Lift**—Get rid of wrinkles without surgery.

Just a sample of some recent articles in Longevity!

SPECIAL CHARTER SUBSCRIPTION OFFER

12 Issues for $9.47 — Save 74% Off the Cover Price

☐ **2 YEARS** 24 Issues for $16 47 ☐ **1 YEAR** 12 Issues for $9 47

NAME_____

ADDRESS_____

CITY_____ STATE_____ ZIP_____

☐ Check encl ☐ Money order encl ☐ Bill me

☐ Visa ☐ MasterCard—Ilbk #_____

Acct. #_____ Exp date_____

Credit Card Holders Call **TOLL FREE 1-800-333-2782**

LONGEVITY PO BOX 3226, HARLAN IA 51593

Canada and elsewhere add $4 00 per subscr pt on Please allow 6 to 8 weeks for delivery Payment must be made in U S currency Regular subscription pr ces $17 97 for 12 issues $31 97 for 24 issues

H2OC6

FOR FASTEST SERVICE CALL: 1-800-333-2782

Omni: If there were no living things—plants or animals—would the cave be much worse for you?

Follini: You know, after a while, even the stones seem alive. I cannot imagine if without any form of life it's not visible, then invisible, some microorganism. Besides, I'm here.

Omni: Do you miss long showers?

Follini: That will be the first thing I do when I come out. In the meantime, I adjust with what's at my disposal—soap and a sponge. Sometimes I even wash my hair, usually after I've taken off the electrodes for the EEG tests. I take a complete bath with a gallon of water.

Omni: Do you have perfume or cologne?

Follini: No perfume. Just incense. I light up every time I empty my chemical toilet. Everything has its own smell. I don't need strong perfume. Anyway, my nose has a good memory.

Omni: The matter of free time and amusements on the space station is really crucial. Should activities be passive, such as reading or watching TV, or active, such as team sports?

Follini: You cannot replace physical exercise in a restricted space, however it is necessary to allocate some space for individual activity. I don't think reading is as passive as watching television. It's very satisfying to create, to be able to draw or play music.

Omni: If you were asked to share your space with another person, what problems would you encounter?

Follini: Coordination.

Omni: Who would you like to share this space with?

Follini: That's a serious question. Not Prince Charming. With my best girlfriend because we would be able to coordinate our activities, work out our disagreements, and have fun.

Omni: If a two-person crew were to go to Mars, should the crew be made up of two women, two men, or a man and a woman?

Follini: I can't make a categorical judgment. All three options could be for the better or the worse. We need to consider each person, their compatibility and ability to share such an experience together.

Omni: Is there any object that you've become especially attached to since you entered the cave?

Follini: I don't think so. Everything has a value based on its use. I love my dish when I eat, my guitar when I play. But I'm not attached to them. In fact, I could do without them like the other things that I don't have here.

Omni: How does the food taste? Do you eat more or less than you did when you were aboveground?

Follini: I wish I could invite you all for dinner, but I'll just talk about it. I love to cook. I prepare lots of good things, sweet things, salty things, spicy things. I've always loved sweets. But just before I entered the cave, I started to prefer salty foods. The scale says I've lost weight, so probably I eat less, even though I have the impression I eat frequently.

Omni: Do you have wine, or alcoholic beverages, in the cave?

Follini: No. And I do not want any alcoholic beverages. I don't like the effect alcohol has on my body. To drink a glass of wine with friends—that's a pleasure. Drinking here would be bad for my stomach and my humor. I don't miss it.

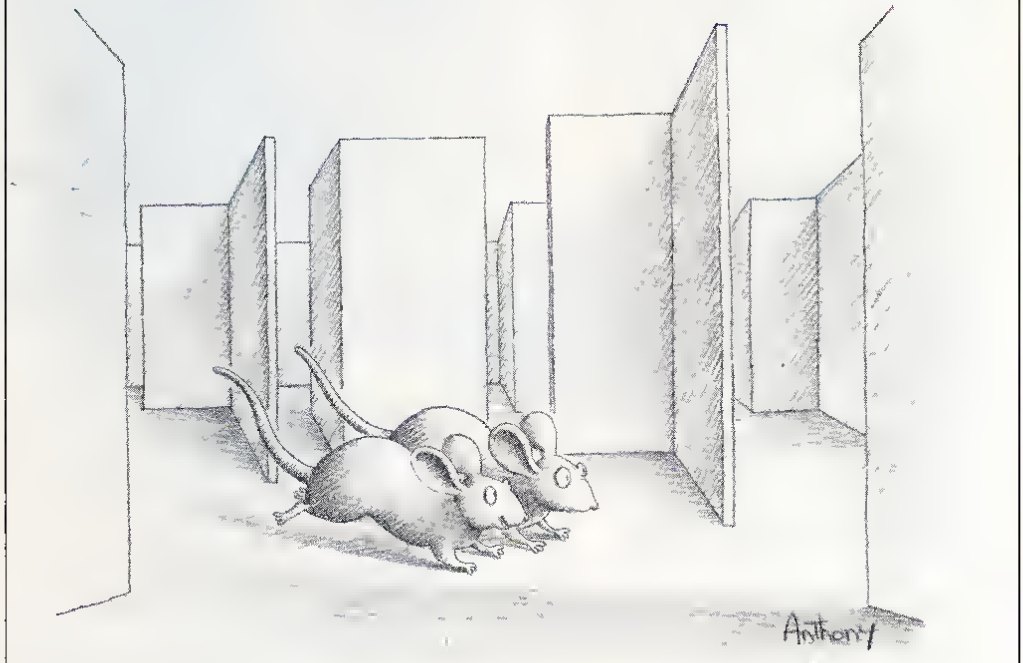
Omni: Do you think spaceflight crews on long voyages should be allowed to drink? NASA doesn't permit alcohol onboard.

Follini: Can you imagine the orbits? Speaking for myself, I don't drink when I'm in training. But a glass of wine during free time on a long voyage might be a tonic for the crew. Wine, though, would spoil during these kinds of trips.

Omni: Does communicating through a computer bother you? Is it too time-consuming, a poor way to express yourself?

Follini: The computer keeps for itself the feelings that animate conversation. In conversation, I love to jest and embellish. The computer cannot relate these affects. It's like a filter. The nice part: you're able to think a bit more before you talk.

Omni: When human beings on Mars are forced to communicate with people on



"I figure if I do well enough here, they might let me get into something creative."

Earth through a computer, what problems do you foresee?

Follini: I don't have any idea. When I communicate to the crew aboveground and I don't receive an immediate answer I don't worry. I know they're busy. But I haven't had an emergency. If I had an emergency and the crew didn't immediately answer, I'd worry.

Omni: On a Soviet flight, a cosmonaut's father died. The ground controllers did not tell him until he returned to Earth. Was that a good decision, or should they have informed him immediately?

Follini: I think it was the best decision. What could the cosmonaut have possibly done besides feel bad during the rest of the flight? By the way, how are my parents?

Omni: Fine, they're perfectly fine. Antarctic explorers sometimes experience a "mental drift" and sensory deprivation while they're isolated. They force themselves to concentrate in order to accomplish tasks. Have you experienced mental drift?

Follini: I have to concentrate in order to complete some tests, everything else seems to come naturally as if I had lived here all my life.

Omni: One team of psychologists examined Antarctic and submarine explorers and found that while certain brain functions such as attention span and perceptual cues deteriorated, other functions such as the ability to become absorbed in beauty and aesthetics increased. Has that happened to you?

Follini: I don't know. [She pulls at her clothes.] I've always had a special love for beautiful things. I hate synthetic clothes or mismatched colors. I'm trying to create a nice environment around me.

Omni: Do you still think that small spaces can be designed in a beautiful way?

Follini: A small space can be designed in a rational and beautiful way. But it isn't always possible to live in small spaces, even if they have been designed perfectly. But I would have said the same thing a year ago.

Omni: When people return from the Antarctic or come back from space, many of them see life differently. They enjoy certain activities more; some even change their priorities. Will you make any changes after this experience?

Follini: I don't know yet.

Omni: From your experience, what type of person is best suited for this type of experience? Can anyone do it?

Follini: Someone who doesn't eat a lot! [She postponed breakfast for this interview.] Seriously, I think a person who goes into isolation must simply be open to whatever happens, physically, mentally and spiritually.

Omni: Can isolation in a cave change a person's basic, fundamental nature? Could it change the human race?

Follini: No. No basic, fundamental changes. You get to know yourself better, change a few things. The temporary absence of human relationships allows you to examine all your relationships.

We signed off. She was beginning to feel dizzy and nauseated; she had not eaten. We had talked for three and a half hours. She thought we had talked to each other about an hour.

As of March 9, the last time I saw Follini by camera, she had been in the cave for 56 days. Because she was in the initial stages of the experiment, the results of the research were very tentative. Montalbini, from the trailer aboveground, keeps vigil over her psyche, noting subtle mood swings, various voice tones and any obvious body language.

Degioanni wants to know how her immune system will fare. After the experiment is completed, DeFrance and his colleagues at the University of Texas Medical School will analyze Follini's REM sleep patterns to see how they were affected. And Galvagno will analyze her blood to check her calcium levels.

Franz Halberg, professor of laboratory medicine at the University of Minnesota, believes that the experiment has already yielded valuable information. Most people's blood pressure peaks by day and drops by night, and differs on weekdays from weekends. "Not so with Follini," Halberg says. "She follows her own built-in cycles: twenty-four-and-a-half-hour days, and weeks just slightly longer than seven days, for heart rates." In fact, Halberg says, Follini's heart rate and blood pressure cycles seem to be "free running"—her cardiovascular system apparently is independent of external cues such as morning and evening, day or night. This is the first time any researcher has tried to track this phenomenon on a person in isolation. "It seems to mean," says Halberg, "that our concept of the week' is partly built-in to our nature—it's not just a culturally influenced thing."

Follini's rhythms seem to mimic her underground cave world, a bizarre and alien environment with its own slow rhythms, measured not from dawn to dusk or season to season but by some seemingly quiet subterranean clock ticking off tens of thousands, even millions, of years. Here in a plastic module, surrounded by technological gadgets and support systems, Follini lives out a dream: to test herself against herself for 100 days of solitude—or more. When she comes out, she'll be greeted by an enormous green metal sculpture made by Italian artist Alzek Misheff. Like a city sitting on a hill, it can be seen from miles away. Representing the stump of a tree with a little leaf sticking out of the side, it's called *Moonleaf. For the Future of Man.*

The whole is greater than the sum of its parts

GAMES

By Scot Morris

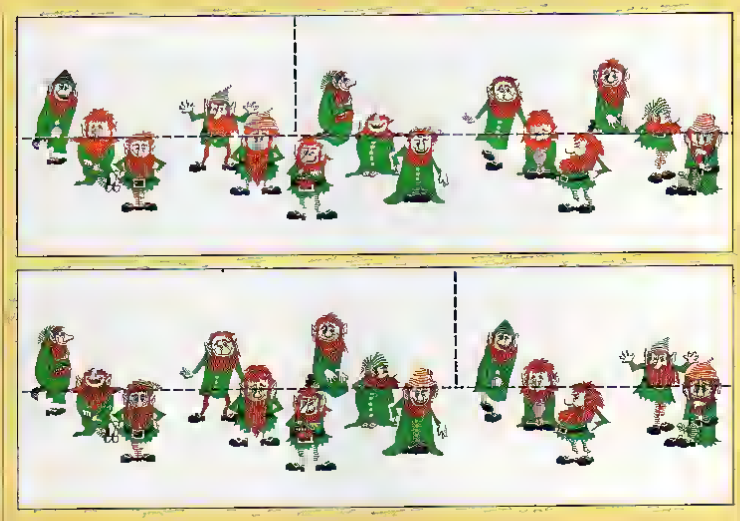
Audiences are thrilled when a magician can make his assistant vanish whether it's behind a screen or in a puff of smoke But when a disappearance occurs in plain sight, the effect can be all the more mystifying and the question "Where did it go?" all the more perplexing A similar effect in the form of a puzzle has also stumped people for years This two-dimensional problem works on the same premise By rearranging pieces of an illustration characters in the picture disappear This puzzle known as a geometric vanish was popularized around the turn of the century by Sam Loyd's version called "Get Off the Earth"

On a paper disc Loyd drew 13 warriors dancing on the outskirts of a globe The disc cut into two sections is pierced through the center with a pin In one position you can clearly see 13 figures but if you move the pieces around the pin one of the warriors seems to vanish leaving only 12 men in view

A more recent example shown above is the 'Vanishing Leprechaun' published by the W A Elliott Company in Toronto This variation is divided into three sections initially showing 15 leprechauns Cut along the lines and switch the two top pieces as shown Now count the leprechauns It seems that one has disappeared Which one is it and how do you account for it?

Up until now the variations on this trick have involved only two different totals Now there's a new version offering three totals This geometric candle design was created by Shigeo Takagi a chemist marine surveyor and puzzle maker in Tokyo Atop the next page is a card with nine candles Cut along the lines and rearrange the top three pieces as follows Move the leftmost rectangle to the far right Move the other two pieces over one space each to the left (as shown in illustration 2) Now there are only eight candles For the third arrangement, repeat the process as in illustration 3, and count again You'll find only seven

Which two candles vanish? Don't be too quick in giving an answer Considering that all parts of the jigsaw puzzle are visible at all times how could *any* candle 'disappear'? The explanation will appear next month so you have plenty of time to challenge yourself and your friends

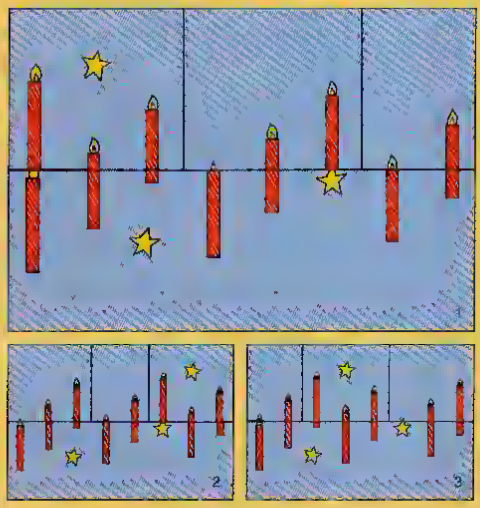


FELLOW SUBMARINE

Remember when submarine races used to be a teenage joke—a euphemism for parking on lovers lane Late this month without sly winks or double entendres, an invitation to watch submarine races will be for real

The First Annual International Submarine Races, sponsored by the H A Perry Foundation and Florida Atlantic University are to be held in the open ocean off West Palm Beach, Florida The purpose of the contest is to inspire further experiments in marine technology These vehicle designs may contribute to improving the hydrodynamic propulsion and life-support systems for small undersea vehicles The novelty of this race is the submarines' power systems, which will be fueled by the human body

Human-powered submarine racing may still prompt giggles, but it's no joke to the competing teams A few of the impressive entrants include the U S Naval Academy Mare Island Naval Shipyard, Naval Special Warfare, Lockheed Advanced Marine Systems, MIT's Sea Grant Program the University of Washington Applied Physics Lab the Florida Institute of Technology the University of California at Santa Barbara and California Polytechnic State University at San Luis Obispo



RACE PARTICULARS

The races will be held June 23 through 25. Sponsors are offering cash prizes to the winners: a $5,000 grand prize for the vehicle with the best overall performance and $500 for each winner in the categories of speed, cost effectiveness, and innovation. All vehicles will race three times around the course—a kidney-shaped, one third-kilometer-long loop—for a total of one kilometer. Vehicles are required to turn in both directions.

Safety concerns have dictated some important restrictions. First, each vehicle will be operated by two people. The teammate designated as the "propulsor" will be the sole source of muscle power, while the "pilot" will be responsible for the steering and safety of the craft.

Second, all vehicles must be free flooding, which means that the operators will be surrounded by water within their contraptions. This necessitates breathing through scuba regulators, so the participants must be certified divers.

The propulsor may use any form of muscle power—arms, legs, or both. Most teams are opting for a bicycle-pedal arrangement, but one entry, designed by Cal Gongwer, will use only arm power.

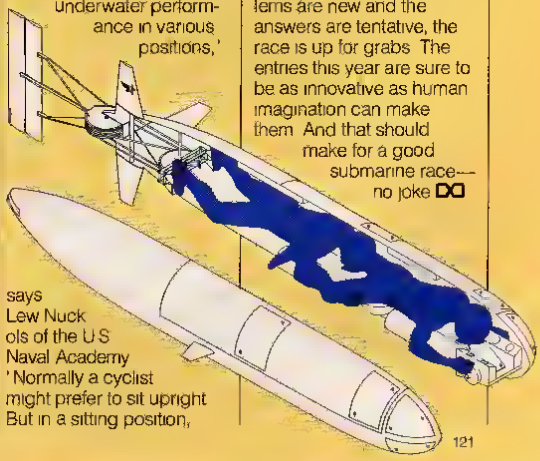
Gongwer, an aerospace engineer and propeller designer, is entering a five-foot clear acrylic sphere. "A spherical shape has never been stable in the water," Gongwer told me, "but I have found a way to control it." Water tends to break away from a moving sphere at unpredictable spots, causing turbulence, but Gongwer's eight-blade propeller is designed to suck the water back into a converging stream. Gongwer says, "I don't expect to win this race. I'm entering it only to demonstrate that my idea works."

Another entrant, Larry Beckman of Seascapes Aquariums in Riviera Beach, Florida, confided that he plans to use tanklike tracks to maneuver his sub along the ocean bottom, 15 to 30 feet below the surface.

The Lockheed team has shunned using a propeller in favor of a vertical blade that will flap back and forth like a tuna's tail fin. The craft (shown below) is aptly named the *Gossamer Albacore*.

Most of the subs will have the propulsor lying on his back but not necessarily for reasons of comfort or streamlining. "We tested underwater performance in various positions," says Lew Nuckols of the U.S. Naval Academy. "Normally a cyclist might prefer to sit upright. But in a sitting position, your lungs are ten to twelve inches lower than your mouth, so when you breathe from a scuba regulator your lungs have to overcome that extra bit of pressure to pull the air down. We found that in a sitting position a diver consumed about twenty-five percent more air and did ten percent less work than when he was in a position where his lungs and mouth are at about the same depth."

Unlike other races, speed is not an immediate concern. A goal of about six knots (6.4 mph) is mentioned. But most designers I spoke to were unclear about projected performance. No one has ever built a human-powered sub before, so no one knows quite what to expect. In future years, as experience is gained, the winning craft will probably begin to look more and more alike. But this year, when the problems are new and the answers are tentative, the race is up for grabs. The entries this year are sure to be as innovative as human imagination can make them. And that should make for a good submarine race—no joke.



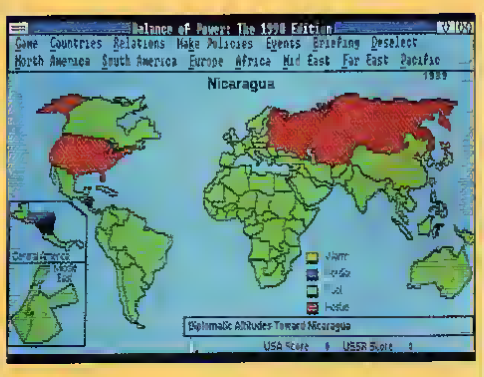
GAMES

If I ran the world things would be different We'd have international famine widespread insurrection mass hysteria, nationwide bankruptcy nuclear war and an occasional town-stomping invasion by Godzilla If *you've* ever wanted to wage war on urban crime or edge a finger dangerously close to the Big Boom Button *Balance of Power The 1990 Edition* (BOP 1990) and *SimCity* will let you find out what would happen

Praised by *The New York Times Magazine* as "the most sophisticated strategic simulation in America other than Pentagon war games," BOP 1990 is a re-creation of eight years (1989 to 1997) of world geopolitics As the American or Soviet leader you observe and react to events and activities in 80 countries, gaining or losing international respect and staving off the final reality of global thermonuclear war

As you extend overt and covert activities around the globe, dole out financial aid and listen to a quartet of computerized advisers BOP 1990 lays bare the tension and the tedium of world politics in a way that newsprint and newscasts can't

Only the most mature tactician will prevail against the imposing volume of BOP's financial military and industrial detail "I've never had anyone complain that BOP is too simple" confesses BOP designer Chris Crawford Although the original BOP settled



for a bipolar "us against them" scenario, *The 1990 Edition* boasts a complex multipolar simulation in which all 80 countries in the game can act with complete and sometimes confounding independence BOP can't capture all the complexities of the real world but its imaginary reality is intricate enough to challenge the most canny amateur politician

BOP's imaginary reality, however has deep hooks in authentic events In fact Crawford was the first to measure his computer world against the real thing "My representation of the Philippines showed a considerable amount of instability there though it missed the fall of Ferdinand Marcos" he says "The Soviet pullout from Afghanistan and the conclusion of the Iran–Iraq war were among other changes that caught me flat-footed I didn't expect either of them to happen this year I figured they needed to spill a few more rivers of blood before reality caught up with them"

Combining intelligence with a game player's sense of mischief Crawford is Dennis the Menace fathered by John Kenneth Galbraith With his outspoken (and carefully cultivated) ability to offend almost everyone, he's developing a reputation as the Sam Kinison of computer game software At a game designers conference for example he illustrated the exploitative attitudes of software publishers by punctuating his remarks with the crack of a bullwhip And last March during San Francisco's West Coast Computer Faire he boldly proclaimed the death of Apple II and Commodore 64 computers But while controversial Crawford is widely recognized as the dean of computer game designers

"BOP is about the principles of geopolitics Crawford explains Those principles don't change and haven't in thousands of years According to the ancient historian Thucydides Sparta's fear of Athens' growing power made war inevitable All you have to do is replace the names *Athens* and *Sparta* with *Soviet Union* and *America*. If you get the principles right you can change the situations and the characters, and the simulation will turn out right"

Meanwhile on the home front, *SimCity* caters to armchair politicians on an urban scale It demonstrates that if you can't fight city hall you *can* join it

Assume the hot seat in Boston before a nuclear meltdown, San Francisco prior to the 1906 earthquake or Tokyo just as Godzilla stomps into town Make-believe mayors allocate funds oversee police and fire departments make long-term design plans and struggle with Mother Nature while trying to advance the quality of life or just survive

SimCity is an ingenious mix of amusement and simulation combining animated city maps with charts and graphs of hardheaded population, crime and financial realities And for those who like Fifties fantasies there's always that surprise Godzilla attack

BOP The 1990 Edition from Mindscape Inc is available for MS-DOS Apple Macintosh Apple IIgs, and Commodore Amiga computers Maxis Software's *SimCity* is published by Broderbund for the Apple Macintosh, Commodore 64 and Amiga computers —Bob Lindstrom

ACCESSING THE FUTURE

TRUE GRIP

Do a little heavy lifting at work or home with these weights (right) from China. Hollow spheres emit tones when rotated in the palm. Use gives fingers exercise and keeps grip firm. Price: $29.95. Contact: Marco Polo Enterprises, Ontario, CA; (714) 947-3391.

SKI TREAD-HILL

Snow's gone; surf's up. But you can keep that downhill form in year-round shape thanks to Le Skizi (above). Device simulates key skiing moves as it trains and conditions. Price: $149.95. Contact: Intromark, Pittsburgh; (412) 288-1300.

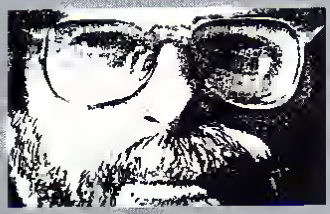
RECLINER AND GENTLER

Sit down to work out with the Isokinetic Recumbent Exercise Bike (below). It provides for a 40 percent more efficient cardiovascular exercise session than standard upright bikes. Price: $449. Contact: ReCreation Unlimited, Mexico, MO; (314) 581-6464.

TOP OF ALIGN

The Gyrotonic Expansion Unit (right) guides and supports the body through as many as 130 variations on 50 different sets of exercises inspired by yoga and ballet.

The machine works major muscle groups in a coordinated fashion, and its circular movements permit dancers and others with state-of-the-art bodies precision strengthening without a loss of flexibility or alignment. The Gyrotonic Expansion Unit was developed by Julio Horvath, a yoga devotee and former soloist with the Romanian State Ballet who now lives in New York City. Price: $25,000. Contact: White Cloud Studio, New York; (212) 695-0083.



LAST WORD

By Sharon Farber and James Killus

Do you remember high school? You know, those four years of living hell? Well, it's reunion time here at Baby Boom Central, and it's your chance to go back and finally avenge yourself.

But remember high school? You know those four unpleasant years between the time you achieved self-awareness and the time you left home. Think back on that eternity when anyone with their assets above the neck was considered a nerd or a brain or (if you're old enough) a grind. Or perhaps you were just plain awkward, unattractive and unpopular—i.e., a typical adolescent who turned to reading physics for fun instead of delving into drugs or mass murder.

Well, it's high-school reunion time here at Baby Boom Central, and it's your chance to go back and avenge yourself. But how? No one wants an unarmed confrontation with the debs, jocks, muscle-bound creeps, and prematurely glandularly endowed who made "the best years of your life" sheer hell. Maybe you're rich now or up for a Nobel, in which case you can go back and flaunt it. Some will try to make do with second-string one-upmanship: whose career has more stress, whose kids are cuter, who's had a novel published by some obscure, small press.

Well, that's not good enough, people! These are grudges we've been nursing for two decades, so why settle for half measures? Luckily for you, our staff has devoted ten years to the development of proven, guaranteed methods of coming out ahead. And now we offer you these helpful hints toward building a more rewarding set of memories for your 50-year reunion. Remember, the best defense is to act offensive.

1. The inappropriate spouse: the easiest tactic and often the most effective. Just bring a spouse of the social or ethnic persuasion most likely to offend and horrify your former peers.

2. The inappropriate spouses: more difficult than the above but also more rewarding. Offer to show pictures of your children. You can have an awful lot of kids in a group marriage.

3a. For men: Come dressed as a priest. Smoke, drink, and make passes at all the women.

3b. For women: Bring your boyfriend, a priest. Then smile indulgently as he smokes, drinks, and makes passes at all the women.

4. When asked what you do, say you're an atmospheric scientist, at least that's what you were before you came down with Epstein-Barr syndrome a few years back. Notice that most of your listeners would rather hear about the late-night sweats and projectile vomiting.

5. Apologize profusely to a former jock for having once called him a dim-witted storm trooper. Be surprised that he can't remember. After all, you've been feeling guilty about it since senior year.

6. Mention your job as a sex counselor. Scrutinize a couple. Offer your card.

7. Yuppier than thou: Have yourself beeped. Repeatedly. Phone the office, hospital, et cetera. The last time you call, yell, "Can't you people handle anything yourselves? Leave abruptly.

8. High-school Spanish pays off: Bring bodyguards who are obvious thugs. Say you're in, uh, imports. Tell anecdotes about Colombia. Fish in your pocket for a cigarette, and remove your hand covered with white powder. Excuse yourself and head for the restroom.

9. The kept-lover ploy: Overdress. Say 'I'd love to invite you to spend a week at my place in Malibu, but Sweetums gets soooo jealous of my friends." Arrive and leave in a chauffeured Rolls.

10. Shave your head. Explain that the world will end on May 22, 1992. Offer to help folks prepare for the great event.

11. You've been driving a cab ever since those narrow-minded bigots refused your doctoral dissertation. Give a blow-by-blow account of your thesis about ancient astronauts who live inside the earth and emerge briefly every millennium to test mankind's worthiness and to meet girls.

12. Bring an imaginary friend.

13. You work in biochemical virology at Fort Ord. Mention something about P-4 containment structures. Cough repeatedly. Say, "It's just something I picked up. Not contagious. Probably."

14. Refuse to eat the hors d'oeuvres. Detail the health-code infractions at the factory where they make those little hot dogs. Explain what "rat hairs and insect parts" really means.

15. Find the classmate who harassed you the most. Shuffle up to him and tell him how miserable he made you. Haltingly describe your years in the institution. "But I'm okay now. I'm *okay now!*"

16. Introduce someone to your Significant Other. Your lover chokes, asks, "That's the one?" and tries to stifle laughter. Act embarrassed.

17. Appear paranoid. Mention that you live in Canada. Start to talk about your days as a student revolutionary. Stop. Look over your shoulder.

18. The National Security Ploy (our favorite): Never introduce your companions, two tall, silent men with dark suits and dark glasses. When asked what you do for a living, say, "I'm in government. Sort of." Admit to owning a house in New Mexico. Be evasive.

19. Explain that most doctors nowadays have no idea of the amount of information they can get through casual observation. Stop. Move your classmate into better light and scrutinize him carefully. Speaking very softly and kindly, explain that the Mayo Clinic is only four hours away by air.

20. Pull out your pocket beeper and say, "Beam me up, Scotty." Disappear in twinkling lights.

Sharon Farber and James Killus, for a small fee, will crash your reunion party and torment your former classmates.