02484

OMNI

JULY 1990

MARS

HOW WE'RE GOING TO GET THERE AND WHAT WE'RE GOING TO FIND

THE LONELINESS OF A LONG-DISTANCE ROBOT

STAR QUEST: HUNTING FOR THE BIG BANG AND MISSING MATTER

$3.50

07

02484

0 778845 1

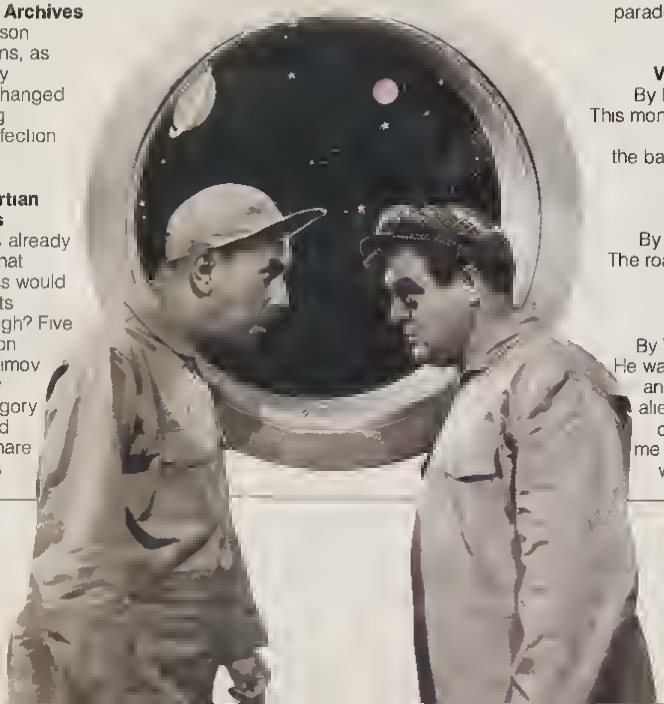
OMNI®

VOL 12 NO 10 JULY 1990

Cover art Kazuaki Iwasaki has produced more than 1,000 paintings of the cosmos including *Spaceships Approaching Mars* painted in acrylic Called the Bonestell of Japan Iwasaki is a self-taught painter and amateur astronomer (Courtesy of Space Art International)

OMNI (ISSN 0149 8711) is published monthly in the United States and Canada by Omni Publications International Ltd 1965 Broadway New York NY 10023 3965 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 12 Number 10 Copyright © 1990 by Omni Publications International Ltd All rights reserved Tel (212) 496 6100 OMNI is a registered trademark of Omni Publications International Ltd Printed in the USA by Meredith/Burda Corp and distributed in the USA Canada United States territorial possessions and the world (except the U K) by Curtis Circulation Company 433 Hackensack Avenue Hackensack NJ 07601 Distributed in the U K by COMAG Tavistock Road West Drayton London UB7 7QE England Entire contents copyrighted Nothing may be reproduced in whole or in part without written permission from the publisher Any similarity between places or persons mentioned in the fiction or serialization and real places or persons living or dead is coincidental Subscriptions U S AFO $24 one year Canada and elsewhere $28 one year Single copies $3 50 in U S AFO and Canada Telephone 1 800 289 6664 The publisher disclaims all responsibility for return of unsolicited matter and all rights in portions published thereof remain the sole property of Omni Publications International Ltd Letters sent to Omni or its editors become the property of the magazine

OMNI



FIRST WORD

By Richard H Truly

"The human race is destined to become a multiplanet species, but before we step off the earth on this journey into the twenty-first century we first have work to do in the twentieth century."

On July 20 1989, the twentieth anniversary of the Apollo lunar landing, President Bush set our country's direction back to the moon and on course to Mars in the twenty-first century. The President proposed "a long-range continuing commitment" to a bold new course in space.

First for the coming decade—for the 1990's—Space Station *Freedom*—our critical next step in all our space endeavors. And next—for the new century—back to the moon, back to the future. And this time, back to stay. And then—a journey into tomorrow—a journey to another planet—a manned mission to Mars.

"What Americans dream—Americans can do," the President said. I believe that. I believe we humans are destined to become a multiplanet species, with the moon and Mars in our future. We at NASA have been working for years to understand the best long-term approach to achieve that goal.

NASA is in the forefront of President Bush's new thrust for the American civil space program, known as the Space Exploration Initiative, or SEI. But before men and women step off the earth on this journey in the twenty-first century, we have a good bit of work to do in the twentieth century. President Bush called Space Station *Freedom* "a first and necessary step for sustained manned exploration." Space Station *Freedom* is essential to our future efforts in space.

Space Station *Freedom* will be a permanent, large, hands-on laboratory for materials and life sciences research in orbit. Later Space Station *Freedom* also will become a stepping-stone for the ships that go to the moon and Mars and a base for the laboratories to analyze what they bring back. On *Freedom* we will demonstrate new and advanced systems and technologies to enable men and women to live and work productively and safely in space and on other worlds.

We will begin the in-orbit assembly of Space Station *Freedom* in 1995 and will begin effective use of it quickly, along with our partners from Europe, Canada, and Japan. By the turn of the century, people from many nations will be living and learning aboard *Freedom*, in orbit 250 miles above the earth. At the same time, we will be developing the new technologies and searching for the new knowledge that must be acquired to enable humans to return to the moon permanently and to explore Mars.

The goal of human exploration of the solar system is a goal that cannot be met overnight, in a year, or even in a decade. This becomes clearer when we consider that it takes from eight to 12 years from the time technology research is initiated until the results are ready for mission application. That underscores how urgent it is to invest now in the advanced technology research we will require.

Clearly, we will need to develop a new generation of heavy-lift vehicles to do this job. The current fleet of space shuttles and expendable launch vehicles is inadequate to launch efficiently the millions of pounds of equipment, supplies, and fuel required for an ambitious project of human exploration. All preliminary NASA studies indicate that a heavy-lift rocket will be needed to deliver that material to space most efficiently and effectively.

Advanced technologies to provide the tools for living and working in space also will be required. An internal NASA assessment of key technologies required for future human exploration places high priority on investments in research in several key areas. Examples are propellant transfer and refueling in space; closed life-support systems; automated rendezvous and docking capabilities; in-orbit assembly and construction; and advanced chemical and possibly nuclear propulsion.

Another pressing need for a program of expanded human space exploration is to augment life sciences research. We need to increase our understanding of the effects of long-term weightlessness on the body's physical and mental processes. It is vital to know more about whether crews can travel long journeys in zero gravity and arrive at their destination mentally and physically capable of performing their mission. The question of creating artificial gravity in space needs an answer. When we go to Mars, it is very possible that such research will have an impact on the design of the spacecraft to get us there.

Both the moon and Mars require further study as well. Where are the resources that we can use to sustain human presence? Where are the best sites for human outposts? What are the environmental conditions on Mars? These questions will be addressed in a robotic exploration program that will pave the way for human missions, at the same time expanding our scientific understanding of both planets. Robots will continue to be used during the human exploration missions to extend human presence and assist astronauts in the many challenges they will face.

NASA's vision is to expand the frontiers of discovery, understanding, human experience, and technology to enrich our country's future. By keeping alive that vision, together we can and will build a better tomorrow for the young Americans of today.

Richard H. Truly, a retired vice admiral and former astronaut, is administrator of NASA.

CONTRIBUTORS

OMNIBUS


CHREIN


BAGNE


PINE


DWORETZKY


FORMAN


BERMAN

Once man stepped onto the moon, Mars became our next frontier. Excited by the increasing feasibility of a mission to Mars, *Omni* president Kathy Keeton inspired this month's issue, devoted to our planetary neighbor.

"If you took all the brainpower of all the folks I talked to for 'Voyage to a Far Planet' [page 34], you could launch me into low Earth orbit," **Brenda Forman** jokes. Having worked in the space field for the past 17 years in both the government and the industrial sectors, Forman says that a Mars mission *should* be our next priority. "I believe in the human desire to explore and I think that space is ripe for human expansion."

Omni associate editor **Tom Dworetzky**, however, quips that we may not have to visit the red planet to meet its inhabitants. "If there are Martians they'll come through New York on their way to wherever they're going," he says. Dworetzky's efforts in coordinating this special issue were augmented by *Omni* consultants **Ed Gutman**, the U.S. editor of *Science in the USSR*, and **Jerry Grey**, the director of science and technology for the American Institute of Aeronautics and Astronautics in Washington, DC.

Ray Bradbury's *The Martian Chronicles* inspired *Omni* fiction editor **Ellen Datlow** as a teenager. "It was one of the first science-fiction books I ever read," she says. "Now I realize the novel isn't science fiction at all but fantasy and is really about small towns on Earth." Datlow commissioned authors **Isaac Asimov, Gregory Benford, Pat Murphy, Bruce Sterling,** and **Joan D. Vinge** to envision Mars today had we landed on the red planet five years ago. Their "Latter-Day Martian Chronicles" begins on page 50. The editor of many anthologies, including *Blood Is Not Enough* (William Morrow) and the recently published *Alien Sex* (E. P. Dutton), Datlow has been nominated for a Hugo Award for best editor.

After speaking to many aerospace engineers and examining various blueprints for *Rover*, a robotic Martian vehicle, **Mitch Berman** conjured up a plausible scenario (Space, page 20). Author of *Time Capsule* (Ballantine, 1988), Berman recently edited *Children of the Dragon: The Story of Tiananmen Square* (Macmillan).

Devera Pine (Stars, page 18) reports on Mars Observer, a planetary observation satellite that will study the Martian climate and atmosphere. Specializing in space and health issues, Pine has written for *Air & Space*.

Life may once have made a valiant effort to thrive on Mars, but the planet was too small to sustain it, says astronomer Sandra Faber. When **Paul Bagne** (Interview, page 62) first contacted Faber, she refused to be interviewed, pleading "monumental deadlines," Bagne relates. So the intrepid Bagne drove to her office at the University of California at Santa Cruz. "I walked right in and said, 'You can't turn us down. You're the only cosmologist who can talk poetry.'" Flattered, Faber agreed to an interview—but only if Bagne conducted it during her flight to Hawaii.

The author of more than 75 works of fiction and nonfiction, former *Omni* editor **Ben Bova** ("Einstein's Law," page 39) is currently collaborating with former astronaut William Pogue on a thriller set on a space station.

Mother–daughter team **Geraldine Youcha** and **Victoria Rab** researched "Power Tools" (Body, page 22) after Rab told her mother about a child named Leah. "I got chills as I listened to the story of this handicapped girl, who can communicate only via computers," says Youcha, whose work has also appeared in *Woman's Day* and *Parents*. Rab teaches graduate courses in special education at George Washington University.

When **Lloyd Chrein** (Artificial Intelligence, page 24) first tried a computer, he became instantly hooked. "It's amazing what computers can do, and what they may be able to do in the future is even more mind-boggling," says Chrein, who is managing editor of *New York Habitat*.

"Mosquito" (page 66) is only the second published short story by **Richard Calder**, a thirty-four-year-old author living in Thailand. ∞

LETTERS

COMMUNICATIONS

Teacher's Pet

I think your magazine is excellent and it continues to improve. Your articles on education [April 1990] were of special interest to me, since I am a high-school junior. I showed several of my teachers the April issue of *Omni* and made them aware of the pressing need to change our educational process. Keep up the good work!

J. Holt Kernodle
Albuquerque, NM

A Less Than SAT-isfactory Test

Your article "Save Our Schools" [April 1990] contained worthwhile criticism of the SAT but overlooked the following fundamental points: 1) The best predictor of college success is *not* the SAT but high-school grades. 2) adding SAT scores to high-school grade point average does not raise the correlation with the criterion of college success by very much, 3) in the vast majority of studies, the criterion of college success is *not* some cumulative criterion of college based on four years of college but only on the first year of college. With all this as well as other misuses of SAT scores, it is absolutely mind-boggling that society tolerates the continued use of the SAT.

Morris Stein
Professor of Psychology
New York University
New York

Thriller

I would like to applaud everyone who was involved with "The Chill of It All" in your April issue. It's truly astounding to me that even though we are in a progressive age of literature, it's very difficult to locate good of' turn-up-the-lights horror stories.

Derek Steele
Bel Air, CA

Staff Inspection

I have never written a complimentary letter to a magazine before. Every month when *Omni* arrives, I bring it to the office with me. Rarely have I been able to read it cover to cover without someone borrowing it. We all enjoy the articles, but it's the art design that blows us away. It is superb, and it just pleasantly surprises us how it tops itself from month to month.

Network/Telecommunications Staff
Metropolitan Life Insurance Company
New York

The Not-so-good Earth

In the warm summer evening I lie awake, listening to truck after truck wind through its gears. The fumes and noise make me wish for winter, when I can sleep without gasping for a breath of fresh air. Our town, Dunmore, in Pennsylvania's Lackawanna County, is known for its boreholes, landfills, leachate, and air full of foul smells ["This Land Was Our Land," Earth, April 1990]. I am a mother of four, and I have little hope that my children will live a normal life unless we move. My parents and my grandparents died of cancer—almost everyone in town has lost someone to cancer. When a person here gets sick, we don't think it's a cold; we think it is cancer. It is a word we have learned to live with and accept. Well, I refuse to accept it. I am not a complainer by nature, but speaking of nature, I'm afraid if I live here long enough, there will be no nature left.

Helen Lancia
Dunmore, PA

The article "This Land Was Our Land" failed to include some important information. The EPA's Superfund Program completed a cleanup of the Keyser Avenue borehole and is now taking the site off the Superfund list. The EPA ordered the companies responsible for the Taylor Landfill contamination to clean up that site and removed 1,200 drums from it. That cleanup was completed in 1988. And the EPA is in the final stage of the Lackawanna Refuse Site cleanup and is also conducting a cleanup at the Aladdin plating site.

Thomas Voltaggio
Director, Superfund Office
EPA Region III
Philadelphia

CONTINUED ON PAGE 92

A HOUSE DIVIDED

FORUM

By Congressmen Bill Nelson and Bill Green

Should we send a manned mission to Mars? We posed the question to two congressmen in a position to influence the decision.

Congressman Bill Nelson, D-Florida, Chairman, Space Science and Applications Subcommittee

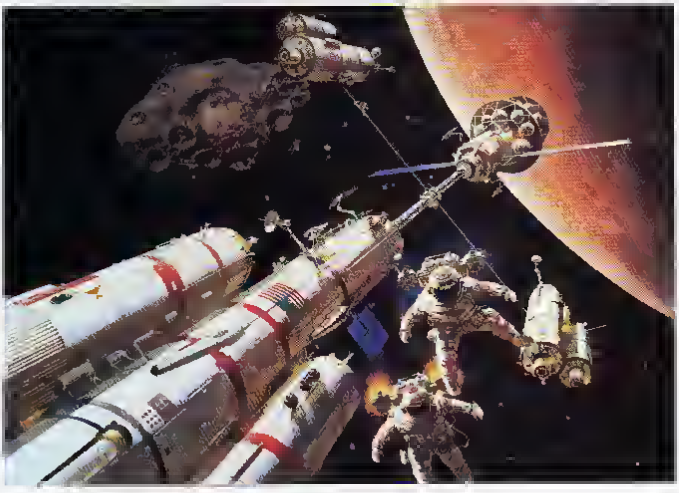
The question America faces is not whether men and women should go to Mars, but who will go and when. Will men and women go to Mars as a joint venture for the benefit of all mankind? Or will it be a divisive race, pitting one nation against another?

Since the birth of science fiction, manned interplanetary travel has captivated our imagination as the hallmark of an almost unbelievable future society. And that future has arrived. We now have the technological capability within our grasp to reach Mars and return. The very nature of humans—the need to explore—makes it inevitable that we will travel to Earth's sister planet.

It's time America committed to leading the effort for Mars exploration. This makes sense for several reasons.

First, America must take decisive steps to maintain its leadership in high technology. I am convinced that the leaders of space and land-based technology will be the leaders of Earth's economy. Other nations will not wait for our leadership, as they might have before the pursuit of high technology became a worldwide race. The list of spacefaring nations since the Apollo program has grown to include China, Israel, Japan, and the European Community. Less technologically advanced nations are showing strong interest in joint ventures. To fall behind in space exploration and exploitation would cause us to lose our economic and political clout throughout the world.

If America stands on the sidelines, we will lose a surefire way of rapidly increasing the number of engineers and scientists available for our technological needs. We saw how the Apollo program created excitement resulting in a dramatic rise in the number of advanced science and engineering degrees awarded to Americans.



Mankind en route to Mars. After all the talk, will there be any action?

Even though our space program did not end in the Seventies and Eighties, without the exciting draw of lunar or Martian exploration, the number of graduates in the sciences dwindled during those years. And at a time when America's future requires increased technological prowess, it is imperative that we offer our fledgling engineers and scientists an enticement worth building a career upon—that of a long-term goal for ongoing space travel, exploration, and development. Space exploration also offers an exciting way to redirect the top talent that has worked on our defense-related industries, as our nation makes use of the peace dividend created by decreased defense spending.

A second reason for a manned exploration of Mars is that the expense would create a perfect opportunity for cooperative efforts between the United States, the Soviet Union, and other nations. The ongoing partnerships between nations on simpler earthbound projects and robotic space exploration carry few penalties for early withdrawal. An international Mars effort would require long-term commitments, cementing beneficial partnerships between the rapidly changing Warsaw Pact nations and the West. Cooperative missions would build upon the relationships now forming between Japan, Canada, the United States, and the European Space Agency in the construction of Space Station *Freedom*.

The third reason is that the exploration of Mars would yield facts about our universe currently indiscernible from near-Earth orbit or the moon. Mars is a dynamic world that may once have been very Earth-like, with bodies of water and an environment much different from its present ice-age state. Understanding how Mars, with its broad parallels to Earth, became such a bleak planet would be useful, as it becomes increasingly important for us to understand our own environment.

The benefits reaped from the technological breakthroughs needed to push

CONTINUED ON PAGE 48

MAKING MARS TALK STARS

By Devera Pine

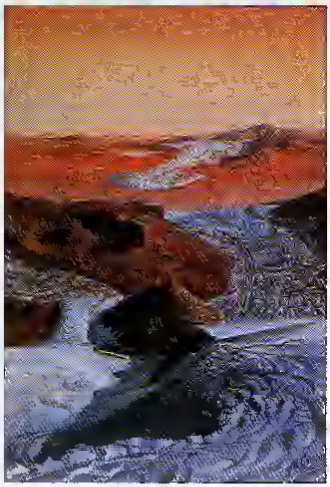
What killed Mars? Observations by *Mariner* and *Viking* spacecraft suggest that the planet once sported a respectable atmosphere and that torrents of rushing water carved many of its surface features. Today, as far as we can tell, the red planet is waterless and the atmosphere has largely vanished. What happened in the past that transformed Mars into the sterile, cold, and lifeless place that it appears to be today?

Theories abound, but with hard data lacking, they remain weak, unproven possibilities. Enter the Mars Observer, a planetary observation satellite slated for launch in 1992 that will study the planet's chemical and atmospheric structure, its climate, and its topography with remote sensing instruments. "The objective is to understand the present processes and circumstances of Mars so that we can understand with some confidence what the history of Mars has been—and then compare that with the history of the earth and Venus," says Frank Palluconi, Mars Observer's deputy project scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California.

Comprehensive raw data are the goal of the Mars Observer's mission, the only data currently available to planetary scientists with a longing to study the planet come from the *Viking* mission. "It will be seventeen years between the launch of *Viking* in 1975 and Mars Observer in 1992," Palluconi says. "When you look at that kind of gap, you can understand why people were willing to make sacrifices, especially given that the other choice was no mission at all."

Sacrifices have earmarked the mission. Following the *Challenger* disaster in 1986, logistical and budget problems hounded the team. "*Challenger* caused a two-year delay," says Dave Evans, project manager at JPL. "There was a period of uncertainty. We didn't know what sort of vehicle it would be launched on." An alternative launch vehicle, the Titan 3 expendable rocket, was secured. Meanwhile, a Congress-mandated budget cap on the mission systematically squeezed state-of-the-art instruments from the spacecraft. Most heartbreaking, says Evans, was the loss of the Visual and Infrared Mapping Spectrometer (VIMS)—a sensitive detector that would have given the team detailed surveys of the meteorological and surface compositions of Mars. "It's been extremely tough," says Evans. "We've spent an awful lot of energy saving costs. But we'll survive."

Survive suggests bare sustenance, with most of the problems surrounding design and budget restraint overcome, however, the team's hopes are flying high. "This will be the longest planetary mission to date," says Palluconi. "It will encompass a full Mars year [687 days]. Mars Observer represents perhaps the first of the planetary orbiters to deepen our knowledge of a planet this way," he points out. "The basic idea is that we can—from orbit—take a look at what is happening on Mars today, how its atmosphere behaves, its temperature, the patterns of its winds, as a key to understanding its past."



Heart of darkness. How could a watery beginning end in a sterile Mars?

Further inspiration has come from the new $1.3 billion space initiative proposed by President Bush. "From the standpoint of engineering people on the team, it's been a real shot in the arm," says Dave Evans. "We were going before that initiative started. By virtue of having been under way, we are the first Mars mission since that program was instituted. It's exciting to all of a sudden have importance attached to our mission and our data."

Success with this mission and the mounds of data scientists hope to procure will have a direct impact on the future of a manned mission to Mars. "The data we are getting are absolutely vital to the next step—rovers on the surface to do a detailed analysis of local conditions," says Evans. The information the Observer provides on the Martian atmosphere will also lead to the design of an aerobraking system so that forthcoming missions can actually land on the planet. That has direct use for robotic and human exploration, notes Evans.

Not only that, but the Mars Observer could be a model for future planetary exploration. Rather than design a whole new spacecraft, engineers are "recycling" tried-and-true designs. The vehicle itself is an updated version of General Electric's successful *Satcom* satellite, first launched in 1975. "If we succeed in maintaining our costs with fixed-price contracts and it turns out to be a productive mission," says Evans, "I think that NASA management would say that's the way to do business."

Besides the practical aspects of the mission, though, there's the fascination with Mars itself. "Mars catches the imagination. It's part of the glamour. We could live there. We could get there and back in a reasonable time," says Evans. "We know enough about Mars that we can start asking detailed questions and get some detailed answers."

Reach the worlds beyond Earth.

Astronomy invites you on journeys to Mars, Jupiter and beyond. Find out all about black holes, pulsars, and enigmatic quasars. Learn how the universe really works!

No packing necessary.
but bring your imagination.

1 year $17.97
12 issues

For a free trial issue* call 1-800-446-5489.

(Monday - Friday 8:30 am - 5 pm)

Or write Astronomy Magazine
Dept. 0152
Kalmbach Publishing Co.
21027 Crossroads Circle
Waukesha, WI 53187-1612

*We will bill you $17.97 (outside U.S. $26.97) for 11 more issues. If not satisfied, write "cancel" on the bill and return. The trial issue is yours to keep.

THE RED PLANET'S LEAN MACHINE

SPACE

By Mitch Berman

Go ground control tells *Rover* But ground control is minutes of radio silence and 189 million miles (or 31,500 New York-to-Los Angeles round-trips) away and cannot know of the sudden dust storm tearing across the Cydonia region of Mars If *Rover* were an ordinary machine it would simply go—and become the most expensive shipwreck in history

When to go may be a ground decision but how is left to *Rover*—because communication between Earth and Mars takes 17 to 40 minutes each way *Rover* must therefore, be able to reason independently And it faces challenges much greater than the simple course corrections of early planetary explorers—such as *Viking* and *Voyager*. Its mission to spend almost three years alone on Mars, traversing faulted, unknown terrain deciding which samples to collect and test It will have only the most general guidance from a distant ground control For *Rover* the difference between success and disaster will lie in how well it can manage the gritty—and potentially deadly—details

The particular detail that concerns *Rover* now is how to skirt the 310 mile per hour winds that will howl beneath it Blasting its deorbit rockets *Rover* maneuvers until it finds a clear line of sight to the surface slows its final descent through the thin Martian atmosphere by unfurling an enormous parachute, and touches down safely on the Cydonian plain It is a perfect landing in spite of the foul weather *Rover* has missed its primary target by just 11 3 kilometers

At ground control ' She hit a dust storm and we find out seventeen minutes later Like we're reading yesterday s paper

' Take your time *Rover*'s programmed to wait forty-eight hours to plot its course toward the primary target

' Landing 11 3 east puts *Rover* on the wrong side of the Face

'The Face? Too steep for *Rover*

'Not for our army of ants, though *Rover* can take the long way around "

Forty-eight hours and 17 minutes later *Rover* rolls westward from its landing package Constructed of three articulated sections each with its own axle bearing two independent one-meter conical wheels *Rover* looks like a cross between a small flatbed truck and a jacked-up jeep A pair of sampling arms—one for chipping and drilling the other for manipulating fine objects—jut from its front end like pincers

Rover reaches the side of the Face a mile-long mesa discovered by the *Viking* mission and named for its resemblance to human features *Rover* extends its manipulation arm backward like a mother cat hoisting a kitten by the scruff of its neck it lifts one of the ' ants ' that are riding on its broad midsection *Rover* sets down all eight of its ants—foot-long six-legged minirovers each painted a different color Then it proceeds around the Face toward the primary target what Carl Sagan has called the 'beckoning pyramids of Mars ' some of them nearly a mile high

A deliberate creature, *Rover* has a top speed of only one-quarter mile per hour Now scoping out the Cydonian plain with a stereo camera analyzing surface minerals with an imaging spectrometer even plumbing the subsoil with an electromagnetic sounder, Rover isn t going nearly that fast

The ants fan out across the Face The red ant climbs over the chin-length hair slowly lifting and setting down one foreleg a few inches until it feels nothing beneath it, then repeating the procedure with each of its other five legs The red ant stands on the nose of the Face Here its chemical sniffer tells of the presence of loose soil and the red ant picks up pebbles with its sampling claw

The black ant finds the topography of the Face considerably more treacherous On the low primitive-looking brow it pauses at a steep crater—one of the Face s deep-sunk eyes Unable to

CONTINUED ON PAGE 97

Rover's mission Spend three years maneuvering at one-quarter mph over Martian terrain

BODY

By Victoria Y. Rab and Geraldine Youcha

When New York City police officer Stephen McDonald was shot in 1986, he was left paralyzed from the neck down, dependent on a respirator to breathe and unable to speak. The twenty-eight-year-old officer couldn't even tell doctors where he hurt. Then his father saw a CNN report on biomedical engineer Thomas Hutchinson and ERICA, the eye-controlled computer he developed at the University of Virginia (U Va). Hutchinson had designed the system—which users operate by focusing their eyes on screen items to choose commands—to enable children with severe forms of paralysis to communicate and learn. Adaptations for use by adult quadriplegics would come later, he thought, until McDonald's father contacted him with a plea to make ERICA—or the Eyegaze Response Interface Computer Aid—available to his son. As the first individual to field-test an ERICA prototype, the younger McDonald used his eyes to write notes, play chess, and "point" to spots on a screen image of his body to indicate pain.

After several months of rehabilitation, McDonald regained partial use of his voice and breathing—enough to control a commercially available computer operated by sipping and puffing on a straw. ERICA went to Thera Thompson, an eight-year-old with above-normal intelligence whose cerebral palsy limited her language to signaling "yes" or "no" by blinking her eyes. Three years later, Thompson uses ERICA to keep up with academic programs Hutchinson's team designs, play games, and conduct conversations.

ERICA is the front-runner in a new category of computers designed to transform the lives of blind and deaf children as well as those who can't speak or hit a keyboard. In 1989 more than 4 million youngsters with a wide range of disabilities—10 to 15 percent of them severely disabled—were enrolled in special education programs across the United States. Many children with severe disabilities are misdiagnosed as mentally retarded because traditional tests can't measure their intelligence. The new systems create pathways for kids to express themselves and for teachers to engage their minds. Blind children write stories in Braille and print them in English, take Braille classroom notes, and study them through a voice output; deaf children learn to speak and read, and those with brain damage learn to write and talk. Eventually, high-tech special education should allow a growing number of computer-literate users to take their places alongside their able-bodied peers.

"Children who might have been relegated to a residential hospital will grow up independently as productive members of society," says Dolores Hagen, cofounder of Closing the Gap, a Henderson, Minnesota, organization that publishes a bimonthly newsletter on computers and the disabled. "They will be able to join the Information Age."

Hutchinson started working on eye-controlled communication in 1984 after watching patients with minimal motor control at U Va's Kluge Children's Rehabilitation Center struggle to control sip-and-puff and mouth stick systems. Many could not even attempt that much. Remembering that he'd been left temporarily paralyzed after an accident in his youth and had been able to move his eyes before any other part of his body, he focused on controlling eye power. His big breakthrough came in the form of a TV documentary on Kenyan elephants. Hutchinson noticed that the animals' eyes glowed when they looked into the camera, a phenomenon called retinal reflection, or "bright eye."

In order to harness retinal reflection, Hutchinson connected a miniature infrared light-emitting diode to a compact video camera and mounted them beneath a monitor attached to an ordinary personal computer equipped with a digital image-processing card. When the light bathes the user's face, it causes the bright eye effect as well as

In focus. Kids—and adults—who can't move a muscle use their eyes to operate a novel computer.

CONTINUED ON PAGE 86

ARTIFICIAL INTELLIGENCE

By Lloyd Chrein

In 1981 AT&T Bell Laboratories set up its Optical Computing Research Department to prove that such machines couldn't work. "I was given the assignment of investigating myself out of a job," says department head Alan Huang. "They just wanted to minimize their risks, and they wanted no maybes." Science is full of surprises, however, and the researchers failed to accomplish their mission. The upshot: Last January they fooled the smart money and successfully built the world's first digital optical computer. AT&T, recovering its corporate composure, now says Huang's achievement "points the way to future exploration."

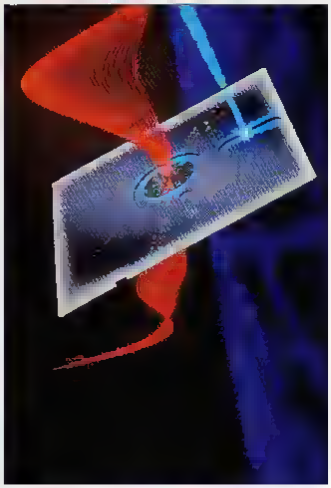
Optical computers use beams of light, rather than electrical wires, to carry information. This will provide designers with a way around the two-fold problem they face when building today's number crunchers. On the one hand, to make more powerful machines, they must pack chips closer together. Unfortunately, when the distance between these components is too small, electromagnetic interference starts to scramble the information they contain. On the other hand, just keeping these units a safe distance from one another is no answer. A machine's top speed is restricted to the length of time it takes for electrons to move data along its wires.

Researchers tried to use lasers in computers when the devices were first developed in 1960. But the technology was too primitive and power hungry. It required about half a megawatt (enough to light 5,000 hundred-watt bulbs) for both power and cooling. In the mid-Eighties, however, investigators successfully created low voltage units for use in CDs, and power consumption dropped to the microwatt range. This advance allowed the AT&T team to move ahead with its computer.

In 1987 researchers at AT&T's Photonic Switching Device Research Department helped develop a second piece of hardware they needed to construct an optical machine—light lenses known technically as Symmetric Self Electro-optic Effect Devices (S-SEEDs). These control the amount of information passing between processors. "They work like photochromatic sunglasses," says David Miller, head of the department. "They open and shut according to the intensity of the light."

The Bell Labs prototype optical processor covers less than a square yard and can operate at more than 1 billion cycles per second. Moreover, each cycle contains a few thousand beams of light, or bits, giving it the potential to be 1,000 times as powerful as a Cray supercomputer.

AT&T has big plans for its discovery. "Imagine all the telephone wires in the world. Each lens in this system can handle all those connections," says Huang. "Calling would be cheaper because we would not have to install so many wires." This higher capacity could permit companies to offer such data-intensive services as pay-per-view home television with thousands of movie titles. Engineers could even use optical channels to link computers. "You can have thousands of inputs to hook up different machines at different times," says Huang.



Out of this world. The machine operates at more than 1 billion cycles per second.

To further develop such applications, AT&T is now selling chips that contain 2,048 S-SEEDs—called compact photonic integrated circuits—to universities. And some academic researchers have already found ways to use them. With a two-year, $100,000 grant from the U.S. Army and Air Force, University of Connecticut electrical engineering professor Bahram Javidi is developing an easily programmable thinking and seeing optical computer able to handle thousands of inputs at once. Optics are ideally suited to such a complex pattern recognition task, physicists have tried for years to make the concept work with electronics but have failed because the required computations took too long. "Most digital computers think in a serial way, one piece of data at a time," says Javidi. "Optics lets us process a large amount of information simultaneously."

Such a computer might help a missile system identify and home in on a target. Machines with the ability to see could also work on industrial assembly lines to identify defects and recognize tools. Such technology could even permit robots to perform simple household chores without falling down stairs or running into walls.

At this stage, however, many experts agree that today's computers have nothing to fear from optics. "Electronics is still the tried-and-true field," says H. John Caulfield, director of the Center for Applied Optics at the University of Alabama in Huntsville. "Electronic supercomputers [which cost about $2 million] remain the state of the art, as do electronic personal computers. We may see optical supercomputers within perhaps ten years, but I doubt we'll see optical PCs anytime soon."

CONTINUUM

COURAGE, MY CHILD

Five years after my flight on Apollo 9, I began to voice some of the musings born in me during my ten-day flight around the home planet in March 1969. As I floated outside of the lunar module suspended between Earth and the cosmos, I was flooded with a wave of uninvited questions: *How did I get here? Why am I here? What does "I" mean?*

I was there largely by chance. Of the thousands of arbitrary decisions I had made in my life, any one chosen differently would have placed me elsewhere. How and why "I" got there was not even a question of "I," but rather "we." (If it wasn't "me" it would certainly have been Alan Bean, or some other astronaut.) "I" was there as a representative of "we." The fantastic thing was that "we" were there, ripping through a total vacuum at 17,600 miles per hour, hundreds of miles above the earth—the biosphere that supports all life that we know exists.

"How" we get there is less interesting to me than "why." What is it that draws us outward? Clearly, we reach outward with our new tools as an expression of the fascination people have had with the stars throughout history. When I was nine years old I wondered aloud about life among the stars as my parents and I meandered along country roads on summer evenings near our farm. When my own teenage kids and I camped in the High Sierras, the last hour before sleeping we always spread-eagled on the highest rock like bowsprits on the ship of Earth racing across the cosmic seas.

There is, I have come to believe, more than just simple wonder with the stars or other life in the universe. I believe this romance is linked directly with survival, but survival in a large and evolutionary sense. Though it is not entirely clear to me, I have formed a metaphor for this process. I see this only "through a glass darkly," but I cannot shake the truth of it.

We are, it seems to me, the product of a planetary gestation, approaching full term. One may choose labels such as *Gaia* or *biosphere* to acknowledge the highly integrated and interactive nature of life on this planet. *But if the earth is an organism,* I thought, *what do organisms do?* They survive, or try to. And nature's primary means of survival is reproduction. Is the biosphere involved in such a process now?

As I began to look more seriously at this strange idea I was struck by the fact that in human birth the end of gestation is marked by an accelerating demand for resources from the mother to sustain the developing fetus. Similarly, the mother processes ever-increasing quantities of waste. The natural resolution of this development is the "birthing process." Through the pain there enters into the world a new life—wondrous, full of potential, quite miraculous.

One need not belabor the analogy to the increasing demand for resources and the production of wastes and toxins in our world today. Nor is it much of a stretch to see the political, economic, and environmental conflicts, or the global climate changes, as planetary contractions. Cosmic birth raises many difficult questions, which as an avowed environmental advocate I find difficulty dealing with. And yet I cannot shake the apparent validity of the concept.

Easing my mind somewhat is the recognition that after birth the child slowly begins recognizing and responding to the mother in a manner honored as one of the purest expressions of love. Having had a part in bringing back those first photographs of our beautiful planet from space, I virtually tingle with excitement as I see the breadth and tenacity of the new environmental attitude developing around the world. People really do care and will sacrifice to see Earth's health protected.

But just where are we in this confusing process? Are we yet born? What are our responsibilities? Is it arrogant even implying that we might have a role to play? First, the full potential of life, and its ultimate survival, lie in being born, not holding back. Second, we cannot truly love and provide for the mother without growing up, developing and maturing. Unnecessary and thoughtless destruction of the earth is no way to love and respect her, or ourselves.

Ultimately, as we explore our new cosmic environment, there is no reason not to thank the Mother with gifts of energy and materials to ease her recovery and honor her continuing beauty.

Courage, child, I tell myself, *courage.* The way ahead may not be easy or even obvious, but it is right, natural, and oh so wondrous!—*RUSSELL L. SCHWEICKART*

CONTINUUM

THE (DOG) BANE OF EXISTENCE

Asian medicine has a long history of dabbling in immortality formulas. Gunpowder, for example, was the side product of a tenth-century Chinese alchemist who was searching for the fountain of youth. More recently, in the June 1989 issue of the Chinese medical journal *Chung Hsi I Chieh Ho Tsa Chih*, researchers reported that the herb *Apocynum venetum*, a member of the dogbane family, might have some antiaging effects."

A concoction extracted from the leaves of this plant was found to lower blood pressure in human subjects by 10 percent after four weeks of use, when used for eight weeks, blood pressure dropped by 13 percent. The treated group also displayed a beneficial 24 percent rise in blood levels of high-density lipoproteins (the "good" cholesterol), and the researchers observed that "cardiac performance improved." When cell cultures were treated with the leaf extract, their life span increased by 4 percent.

While all this sounds encouraging for future study, Varro Tyler, a professor of pharmacognosy (the study of pharmaceuticals derived from natural sources) at Purdue University, warns that it would be foolhardy for anyone to wolf down dogbane just yet. "*Apocynum venetum* contains some very potent compounds that influence heartbeat," he says. "It shouldn't be used without medical supervision."

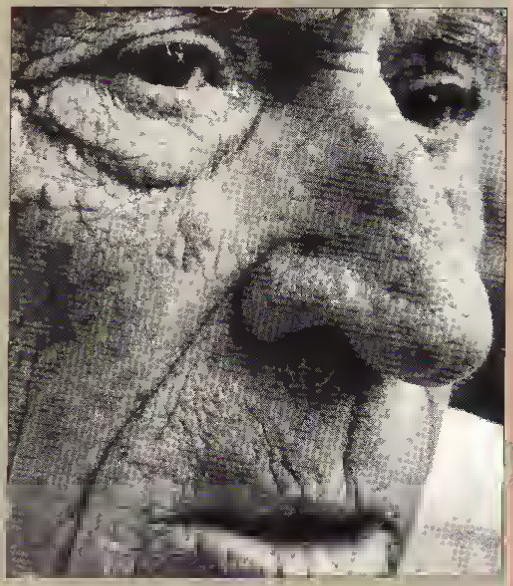
—Mark Sunlin

"Unfailingly, humans pity their ancestors for being so ignorant and forget that their descendants will pity them for the same thing."

—Edward Harrison

"Education is what survives when what has been learned had been forgotten."

—B. F. Skinner



Fountain of youth, where are you? A report from China highlights the latest candidate for increasing human life span

CHILL OUT THE LOLLIPOP WAY

At least one species of lichens, those heartiest of plant pioneers, manage to survive the winter by converting the water in their root and vascular systems from a liquid to a glassy solid phase without freezing. Cryobiologist Gregory Fahy is attempting to do the same thing, not with plants, but with human donor organs.

Fahy heads the Organ Cryopreservation Project for the American Red Cross in Rockville, Maryland. Traditional freezing, he explains, causes severe damage to human organs. "Kidneys, for example, are very sensitive to ice," Fahy says. As liquid water turns to ice, it "rips up the scaffolding material that holds the cells together," destroying the organs.

Fahy is trying to control the damaging effects of freezing the same way lichens do, through vitrification. "In vitrification the liquid becomes thicker and gooier like molasses," he says. "Essentially, you're slowing everything down rather than stopping it." The process, still in an early phase, has shown promising results with rabbit kidneys.

The goal of Fahy's research is to buy time for patients in need of organ transplants. Currently kidneys, livers, and hearts must be transplanted within a few days after being removed, a constraint that makes these operations expensive. "If we can store kidneys from six months to five years, we should be able to find a good match between donor and recipient in about ninety percent of the cases," he says.—Steve Nadis

Lollipops and kidneys: Both turn solid without freezing

"In the works of Nature, purpose, not accident, is the main thing."

—Aristotle

THE DAY THE EARTH SLOWED DOWN

January 24, 1990, was a typical day in most respects Civil war flared in the Sudan, Japan launched its first rocket to the moon, and a Long Island, New York, nurse was convicted of killing four patients

A typical day—but a little longer than most From January 24 through February 3, the earth's rotation slowed down, extending the length of the day by five ten-thousandths of a second As a result of the ten-day slowdown, a day is now two thousandths of a second longer. "That s as long as it has been in years,' says Dennis McCarthy, an astronomer at the U S Naval Observatory

According to geologic records, the earth has been gradually slowing down for millions of years, probably because of an increase in the frictional tidal forces of the oceans rubbing against the planet's crust The recent slowdown was 'more abrupt than usual," says McCarthy, "but not a once-in-a-lifetime event These things can happen"

Although the El Niño current, which develops in the central Pacific, has previously affected the length of the day, it does not appear to be the culprit this time Some meteorologists suggest the slowdown may be connected to an abnormally high number of 'westerly bursts," strong winds coming off Asia onto the Pacific When the average speed of these winds increases, friction increases, and the planet rotates more slowly

The longer day makes life interesting for those in the measurement business "We added one leap second in December of last year, and another leap second two years ago,' McCarthy says "If the lengthening of the day continues, we'll probably have to put in leap seconds more often—maybe once a year"—Steve Nadis

Ignoring the speed zone Planetary rotation seems to dismiss the tidy formulas geologists have assigned to it

SUPERMAN DID IT WITH HIS BARE HANDS

Nature creates diamonds deep inside the earth by compressing carbon and subjecting it to tremendous heat and pressure In labs, technicians make synthetic diamonds, prized by industry as supertough cutting and grinding aids, by heating and compressing graphite In the Soviet Union, scientists have developed a way to make diamonds at room temperature simply by shining a laser beam on carbon soot

Soviet scientists Boris Derjaguin and Dmitri Fedoseyev, at the Institute of Physical Chemistry of the USSR Academy of Sciences, produced diamond powders by passing a medium-powered infrared laser (50 watts) over graphite and carbon soot Because the laser pumps so much energy into the carbon so quickly, explains Penn

The big squeeze Yet another way to make diamonds

State materials scientist Rustum Roy, who repeated and confirmed the experiment, the carbon does not have time to expand normally and instead is compressed as if under great pressure

The Soviets' technique, says Roy, converts only about 1 percent of the carbon into diamond, making it too inefficient to be useful in industry at present But, he says, materials scientists working in concert with laser scientists could make the process more efficient and more profitable —Bill Lawren

---

"Why, sometimes I've believed as many as six impossible things before breakfast"

—Lewis Carroll

"It's deja vu all over again"

—Yogi Berra

"Too much of a good thing is wonderful"

—Mae West

CONTINUUM

Lassie knows best The bright canine notices Timmy has fallen asleep when the lad should be at school Dogs with similar sensibilities are being recruited to help the handicapped

PSYCHIC POOCH

After sustaining a head injury in a 1984 car crash, Victoria Doroshenko suffered from daily, severe epileptic seizures She often broke bones or injured her head when she fell during these episodes Then she was frequently confined to a wheelchair That s when the Washington State woman began searching for a dog that could carry her belongings, pick up her crutches, or pull her wheelchair The dog she found, a golden retriever named Harley, turned out to be more help than Doroshenko could have ever imagined Harley, it seems, can sense when she is about to have a seizure and warns her, sometimes up to 45 minutes *before* a seizure begins

Soon after taking Harley home, Doroshenko was startled when the dog suddenly refused to obey commands and began running around her "I sat down and went into a grand mal," she says 'Ever since, Harley has been forewarning me of seizures He breaks my falls If I'm alone he ll go for help '

How could a dog predict epileptic seizures? Reina Berner, executive director of the New York-based Epilepsy Institute suggests several possible explanations Berner says Harley may be able to detect mild behavioral or physiological changes—imperceptible to humans—that a person may exhibit before the onset of a seizure ' Or, ' says Berner "it could be that the animal somehow picks up changes in the electromagnetic fields in the person's brain.'

Berner would like to isolate the cues Harley picks up on so that other dogs can be trained as safety companions for people with epilepsy 'Before I got my dog " says Doroshenko, "I was afraid and housebound Harley gave me my life back.'—Sherry Baker

---

"Except our own thoughts, there is nothing absolutely in our power"

—René Descartes

"Speak softly and own a big, mean Doberman"

—Dave Milman

ADS IN ORBIT

For years entrepreneurs have been talking about the 'commercialization' of space, but so far only millions of tiny plastic spheres, used to calibrate scientific instruments, have been manufactured in orbit Well, get ready for the *real* commercialization of space The Soviet Union recently hired an advertising agency to hawk its *Mir* space station as a one-of-a-kind location for TV commercials

' We have visions of cosmonauts munching on candy bars, wearing sneakers, writing with pens,' says Buckner Hightower, chairman of the Aerospace Marketing Group, which has exclusive North American rights to sell ad space on *Mir*

Ten companies are seriously pondering the offer, says Hightower, who hoped to sign at least one agreement in time for the planned change of crews on the space station in late June

It will cost a minimum of $500,000 to shoot a commercial aboard *Mir* Companies will select the cameras of their choice, the Soviets will train the cosmonauts to use them The Soviet Union has also agreed to let cosmonauts practice with the cameras in its microgravity simulator in Star City outside of Moscow

The commercials will no doubt lack the studio-quality sheen that we've come to expect from ads Nevertheless, Hightower hopes that the novelty of an on-location space commercial will draw ad agencies to new heights —Devera Pine

SIX–LOVE

Ever since Englishman Walter C. Wingfield devised the modern game of tennis in 1873, players have been flailing away with a racket that has an eight-sided grip. Now exercise scientists at the University of Massachusetts–Amherst have cut two corners, producing a six-sided tennis grip that they say is measurably superior.

The six-sider is the handiwork of Andrew Brown, a reformed Ping-Pong player and mathematician from Cincinnati. In a study of 30 well-seasoned tennis players at UMass, Brown used high-speed cameras and computers to chronicle the torque, force, acceleration, impact, and accuracy of their strokes with the new grip. In terms of shot placement accuracy, they averaged a 13.9 percent improvement in forehand strokes and an almost 9 percent advancement in their backhands.

"Tennis pros always tell beginners to grip the racket as though they were shaking hands with it," says Brown, "but an eight-sided handle turns the racket faceup slightly on a forehand shot and a bit down on a backhand—unless you rotate your hand slightly. Beginners usually hit forehands over the fence and chop backhands into the ground."

Brown's grip forces a player to grasp the handle correctly, eliminating the need to make the adjustment consciously. A six-sided grip, says Frank I. Katch, chairman of the UMass exercise science department, produces a "very strong anatomical position, the optimum position, in fact." Brown notes that his invention could banish tennis elbow by eliminating the slight rotation of the forearm necessary to hit the ball correctly, reducing stress on the joint. The grip is currently under evaluation by two major racket manufacturers and could make its appearance this fall.

—George Nobbe

Racket man. John McEnroe puts the blame where it belongs.

"Virtue is its own reward."
—John Dryden

"Virtue is its own revenge."
—E. Y. Harburg

"A little ambiguity never hurt anyone."
—Charles Suhor

"Almost anything is easier to get into than out of."
—Agnes Allen

Beehives turn out to foster a bee eat bee populace despite their reputation as paragons of social cooperation

BEES OF THE ME GENERATION

The buzz around the beehive is that there is a workers' uprising—a new labor movement that's been spotted by two University of California (UC) scientists.

In the honeybee colony the queen is the only female with license to reproduce. Nonetheless, some female workers have been found laying unfertilized eggs. This is cheating other members of the hive, say entomologists Kirk Visscher of UC Riverside and Francis Ratnieks of UC Berkeley. Neither the queen nor other hive members benefit from raising a renegade worker's offspring.

Left alone, workers unfertilized eggs develop into drones, male bees whose sole purpose in life is mating. But they aren't left alone, the researchers observed other females "policing" the hive, seeking out the eggs of self-promoting females and devouring them.

The workers can probably tell a queen's egg by scent, but entomologists believe cheaters' eggs don't have this odor, thus they become fair game. The researchers believe the predatory workers may be safeguarding their own genetic investment. Because the honeybee queen mates with ten to 20 drones, each worker is likely to be more closely related to her brothers than to her nephews.—Dava Sobel

CONTINUUM

SEA SPIT

Ringo Starr may be perfectly comfortable in an octopus's garden, but true beetles would hate it. Aside from drowning, these and other bugs would find the octopus's presence lethal.

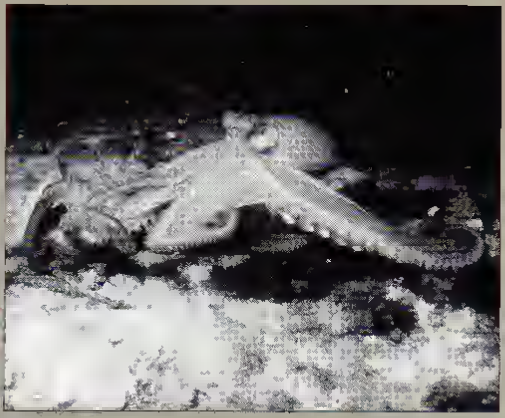
Substances present in octopus saliva, says neurologist James Nathanson of Boston's Massachusetts General Hospital, "can induce behavioral changes in insects." When these substances are sprayed on the leaves of plants that bugs eat, for example, the insects "develop tremors, become uncoordinated, and fall off the plants."

The substance's use was first discovered more than 40 years ago by an Italian pharmacologist looking for rare bioactive substances in animals such as snakes. "They all have venom that affects the nervous systems of their prey," says Nathanson.

The easily synthesized compound, called octopamine, stimulates insects' nerve cell receptors, delivering an overdose of activity to these cells the same way that caffeine produced by coffee trees overstimulates insects that dare to munch their leaves.

The ideal organic pesticide? Not just yet, says Nathanson. The problem facing the neurologist is that each bug has different types of nerve receptors, all of which must be classified before anyone can design an octopamine elixir that will leave beneficial insects alone while doing away with harmful ones. "Insects have dozens of neural transmitters," says Nathanson. "We're searching for the receptors that are overloaded by the substance. It should work, but I can't say that tomorrow we'll have an octopamine pesticide."

—George Nobbe



A spineless mollusk that packs a real punch. From the undersea world comes what may be the perfect means for downing insect pests.

AN ACID TRIP

Remember the little Dutch boy who plugged a leaky dike with his finger, saving his country from a ruinous flood? If Olaf Schuiling's idea for keeping Holland high and dry is equally successful, he, too, may become a well-known national hero.

Schuiling, a chemistry professor from the University of Utrecht, suggests using sulfuric acid to raise land levels. It's a matter of simple chemistry. By boring holes some 1,500 feet into the ground and injecting sulfuric acid into them, a chemical reaction occurs with the limestone that underlies most of Holland. The reaction, in turn, expands the rock to twice its original volume, lifting the ground above it out of the reach of the steadily encroaching sea.

"When the idea first occurred to me, I thought it was more science fiction than science," Schuiling recalls. "But when I playfully discussed it with some colleagues, they took me more seriously than I expected."

The sulfuric acid for Schuiling's plot would come from Holland's industrial waste. Schuiling calculates that one year's worth of waste acid would add three feet of elevation to a stretch of land about seven miles long and 300 feet wide. "Laboratory tests have succeeded. Now I am trying to arrange a large-scale experiment and a feasibility study," says Schuiling. As a test site, he suggests Ameland, a small island off the northwest coast of Holland.

Will toxic chemicals dissolve Holland's need for windmills?

Dutch authorities are optimistic but cautious about Schuiling's proposal. "We are very interested in what he suggests," says Pieter de Wildt, a policy adviser at the Ministry of Transportation and Waterways. "But we want to know much more about it before trying to apply it."—Doron Pely

"When we look at a rock what we are seeing is not the rock, but the effect of the rock upon us."
—Bertrand Russell

"Boredom is not only a judgment about experience but a sin against ourselves."
—Robert Grudin

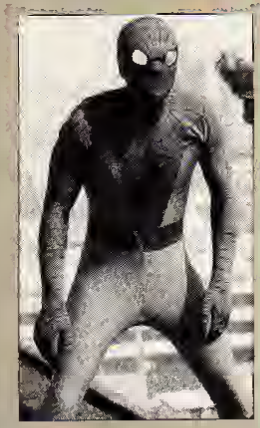
THE ITSY-BITSY SPIDER LAB

"What am I? I'm more elastic than nylon, five times stronger than steel, and tend to collect in corners and eaves" If you guessed spider silk, give yourself a handful of jelly beans

Molecular biologist Randy Lewis of the University of Wyoming says that spider silk would be ideal for sutures, artificial ligaments, aircraft carriers' catch cables, body armor, wet suits, and even space suits Add it to plastic car fenders and it probably would "take a significant impact, flex, and bounce right back again," says Lewis

Under a grant from the Office of Naval Research, Lewis is working to unlock the secrets of spider silk His favorite subjects are Florida's golden orb spinner and Wyoming's catface spider, prized for the amount and quality of the silk they produce. After restraining a spider, Lewis draws silk from it with a variable-speed reversible drill, coaxing "as much as one hundred yards" in a single session A single spider can be "silked" up to three times a week so long as it's kept well fed

Lewis has no problem getting the silk from anesthetized arachnids, but then getting the gene responsible for silk production to reproduce in a bacteria culture has proved to be a stumbling block "They [the bactena] don't seem to like it," he says Lewis adds, however, that as soon as an amiable culture is found, the genes will undoubtedly thrive in the culture and produce fibers that can be spun into an all-purpose thread He predicts that super silk should be available for experimentation in about a year.—Peggy Noonan

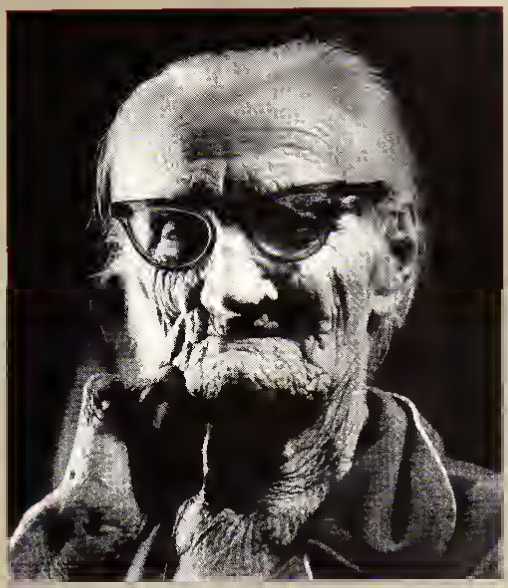


The web-headed hero shoots stuff that's stronger than steel

OPEN WIDE AND SAY MICROPHAGES

If you worry about bactena, plaque, and tooth decay, take comfort in the knowledge that a mouthful of microphages may do you more good than all the toothpaste, mouthwash, and dental floss in the world

Microphages are very tiny viruses that attack and devour bactena, and Alan H Norris, a chemical engineer from Rome, Georgia, believes they can be applied to fight tooth decay Norris says that because viruses develop naturally for virtually every kind of cell, a specialized phage can be found that destroys only microbes harmful to teeth.



Look, Ma, no teeth: To stave off the woes of a rotting mouth, throw away your toothbrush, says a chemical engineer from Rome

"Phages are pretty tough little buggers," says Norris, adding that they could easily be mixed with toothpaste and mouthwash. Once in the mouth the microphages could consume bactena that breed on the surfaces of teeth The *Streptococcus sanguis* bacterium initiates tooth decay, with *S. faecalis* and *S mutan* joining in later "The implication," Norris says, "is that one need only provide phages that eliminate *S sanguis* to prevent ninety percent of dental cavities"

For those of us reluctant to swish alien viruses in our mouths, Norris quickly responds, "Phages are absolutely harmless They attack one specific bacterium and produce no side effects. And because they are not a drug, they probably won't need FDA approval."

Norris says that certain tooth-care companies have expressed interest in his patented method of combating tooth decay, but what's really needed is financial support to help him identify and then custom-breed the proper phages.—George Nobbe

"If man could be crossed with the cat, it would improve the man but deteriorate the cat"

—Mark Twain

CONTINUUM

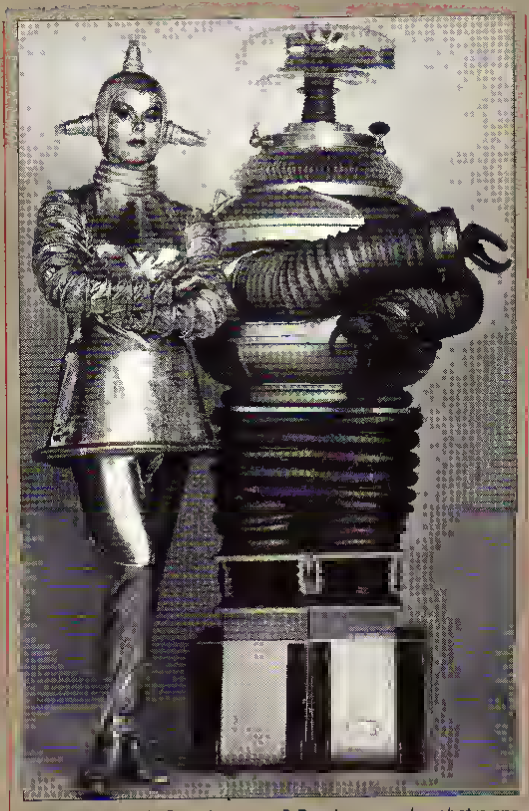
HE SWEEPS, HE SCRUBS, BUT HOW'S HIS FRENCH?

There's a new figure in the Paris underground these days. He's a fully automated robot that goes by the name of Cab-X, and he cheerfully (well, at least uncomplainingly) does a job no one else wants to do. He cleans those endless expanses of pavement in Paris's metro system.

Cab-X, who stands about six feet tall and weighs in at close to 200 pounds, gets his power from a battery pack and moves about on tanklike treads. He's guided by clusters of magnetic discs embedded in the station's pavement and by an artificial vision system that allows him to avoid such obstacles as scurrying passengers. He sweeps and vacuums (no, he doesn't do windows), and when he's through tidying one station, a human instructs him to hop a train, ride on to the next stop, and clean up there.

Cab-X, who was designed and built by the French firm Comatech, is actually part of an ambitious research program launched by the RATP (the Paris transit authority) in 1983. He costs about $82,000, and now that his testing period has been completed successfully, he and four other robots are slated to start a regular work schedule later this year. But will he and his pals be able to survive a Parisian rush hour? "We haven't used him at rush hour,' says RATP spokesman Bernard Loescher. 'Too many obstacles."

—Bill Lawren



Iz zis zee ansair to Paree's prayers? Bossing around a robot is one way for the French to get their work done.

SUPPORT YOUR LOCAL MARS PROBE

Last January President Bush took the first step to revive America's flagging space exploration program, proposing a 22.8 percent increase for NASA's 1991 budget, $1.3 billion of which would underwrite a lunar–Mars exploration program. But Congress may curtail Bush's plans after reviewing the budget this summer—trimming—rather than bolstering—space funding.

Enter Spacecause, a lobbying group that hopes to forge a powerful grass-roots movement to persuade Congress to leave the space budget alone. The organization hopes to garner support for the Bush proposal from aerospace companies, the science-fiction community, the astronomy community, and the pro-space public, says Mark Hopkins, Spacecause's president.

"If you look at peak space funding in the Sixties," says Hopkins, 'it was one percent of the gross national product; now it's about a quarter of one percent. The space program didn't break us then even though we were fighting the Vietnam War. We think the country can afford it.'

Funding the space program is imperative for many reasons, says Hopkins. 'If the lunar–Mars program gets shut down, humanity's push into space is going to be seriously curtailed. We're making a choice about our space program's future. Is it going to be relatively small or is it going to be aggressive?'

Hopkins urges anyone who wants to register support for the president's space proposal to contact those heading the space budget committee: Senator Barbara Mikulski, 320 Hart Senate Office Building, Washington, DC 20510, (202) 224-4654, or Congressman Bob Traxler, 2364 Rayburn Building, Washington, DC, (202) 225-2806. —Shari Rudavsky

"The health of the eye seems to demand a horizon. We are never tired, so long as we can see far enough."

—Ralph Waldo Emerson

"The greatest obstacle to discovery is not ignorance—it is the illusion of knowledge."

—Daniel J. Boorstin

Colonizing the red planet will take the combined efforts of the world's best space brains. The $400 billion question. Can nations cooperate well enough to make this dream come true?

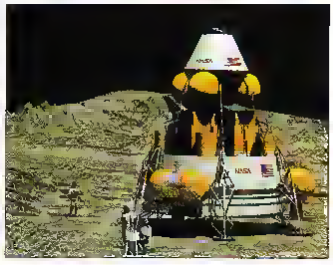
VOYAGE TO A FAR PLANET

ARTICLE BY BRENDA FORMAN

Aboard the spaceship *Glasnost,* 23 million miles on its way to Mars, Baryshnikov (so dubbed for his annoying habit of repeating the *Swan Lake* adagio for hours in the low-g exercise module) had stopped shaving his face. He had elected to use his electricity ration to do his armpits once a week instead. Spiderman was indifferent to this. He was more interested in the web of Kevlar monofilament he'd woven in the radiation shelter. Besides, he hadn't changed out of his black tights for half a year and Baryshnikov was the only one who had said nothing—so a silent bargain had been struck. Baryshnikov, a.k.a. F. Povich, cosmonaut of the USSR, and Spiderman, a.k.a. P. Hoffman, astronaut from Houston, had shown

PAINTING BY MICHAEL CARROLL

Besides the $400 billion sticker shock, the space technology needed for the trip is no longer exclusively Made in America



the unmistakable signs of irreversible space psychosis.

The six other crewmen had their *f-a-c-u-l-t-i-e-s* somewhat more intact. They had gathered in the galley to make the decision.

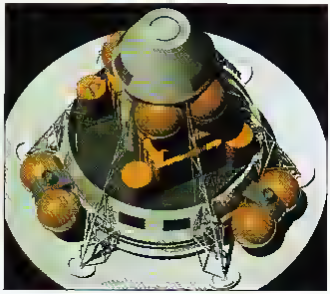
"They could sabotage the entire ship," Akira from Nagano, Japan, had pointed out.

"We must not act in an uncivilized and immoral fashion, however," advised Mohan from Bombay.

"We must conform to due process of law," Jean-Paul the Parisian agreed.

They decided to isolate Baryshnikov and Spiderman in the exercise and shelter modules. That way, if they blew an airlock, started an electrical fire, or found a more novel method to merge their souls with the black void, they wouldn't take the other six astronauts along with them.

The six did not discuss their decision with ground control. After all, who knew what the others back at the lunar base, or at mission control, might do?



The six were having a little trouble with the isolation, too.

"A trip to Mars will be the most challenging high-technology adventure of the twenty-first century," says Tom Paine, former NASA administrator and chairman of President Reagan's National Commission on Space. Getting there, however, makes a lunar flight look like a jaunt to the corner store. While the moon is a "mere" 250,000 miles away, Mars can be anywhere from 49 million to 235 million miles from Earth, depending on the time of year. One round-trip could take three years or more, not counting time spent on the surface.

Along the way, human colonists will live for months or years in cramped spaces. In the meantime, politicos will be maneuvering back on Earth, persuading half a dozen nations to split the tab on this pricey journey. The $400 billion (NASA's preliminary estimate) sticker shock, however, isn't the only reason that the United States is unlikely to go to the red planet on its own. The space technology that such a big journey demands is no longer exclusively Made in America.

The Soviet Union, the European Space Agency (ESA), Canada, Japan, and China all have very impressive space capabilities—including rockets, robotics, and space-medicine expertise. Recognizing this, President Bush announced in March that the United States plans to seek an "exploratory dialogue" with Europe, Canada, Japan, the Soviet Union, and other nations on international cooperation in the Space Exploration Initiative.

Even though no one knows what shape such "international cooperation" will ultimately take, there's certainly enough scientific and technological work to involve everybody.

"Every way you look at SEI [Space Exploration Initiative, i.e., moon–Mars in governmentspeak], it's a whole cluster of cooperative opportunities," says Peter G. Smith, director of international relations for NASA. Fitting the pieces together will be the most complex sys-

A roaming holiday. At the Martian outpost (top left), spacepersons prepare to board a surface craft. To get to Mars, voyagers will fly aboard a transfer vehicle (top right). To chart new territories on the surface, explorers use a larger surface craft (right). Colonists descend from orbit to the red planet aboard a reentry vehicle (below).

tems integration job ever Meanwhile the project's international organizational structure will have to function for 30 years or more—a staggering prospect given the routine mulishness of politicians and the vagaries of history (Remember the furor last year when NASA offered Congress a scaled-down space station design without first consulting the other nations involved with *Freedom*?) Even before the first crew leaves for Mars, there's a formidable clutch of technologies to master—both "hard" ones for hardware and systems, and "soft" ones for keeping space colonists sane and healthy

IS 'INTERNATIONAL COOPERATION" POSSIBLE?

"The Americans are talking about cutting their Mars mission budget once again, sir"

"They do this to us every year, don't they? You'd think they'd persevere in something they started themselves but they never do. I suppose we should have learned that back in Space Station *Freedom* days."

"Minister says we should think about redesigning our module to be completely independent Then we can let the Americans dither without queering our own projects."

"Mmm More expensive that way of course But worth looking at."

The politics of moon–Mars will probably be absolutely Byzantine. "The technological challenge is probably equaled by the institutional challenge to organize a sustained international effort extending over decades," explains Paine Sending voyagers to Mars will involve a broad consortium of nations and stretch over three decades or more

The only project remotely resembling such an ambitious endeavor Space Station *Freedom* has the United States as its leader, manager, and ultimate arbiter of operating decisions. "That could be the Mars model—if the United States cares to pay the bulk of the gigantic amount of money involved, as it is doing with the space station," says Ben Huberman, President Carter's deputy science adviser and now a Washington consultant on technology issues Even more important, the nation would have to commit to paying out that money consistently over the extended time period of a Mars mission, a condition Congress will undoubtedly reject.

The *Freedom* model may not prove flexible enough for the moon–Mars initiative Although big and complex, the space station is essentially just one single piece of hardware. Moon–Mars will require a very large number of separate elements—bases, stations, launchers, and landers—each of which could involve different players. For example, according to a high NASA official who requested anonymity, Japan is already deeply interested in lunar resources, so it might want to participate in a moon base. The Soviets, on the other hand, prefer a Mars mission over a return to the moon. Each piece of the action, therefore, will probably end up tailored to the various participants' goals

Paine says a good management model might be Intelsat (International Telecommunications Satellite), to which each nation contributes to the degree it uses the system. "Pay your dues and get your ride." Another model, the approach ESA has pioneered in coordinating the space efforts of 13 countries with different technology levels, funding resources, and policy objectives.

But would the United States agree to any arrangement in which it would be a mere partner rather than the leader? "I don't think we'll go to Mars as part of an organization in which we lose the perception of the lead," says the same anonymous NASA official. "That tugs at the U S heartstrings Leadership is one of the main reasons the President put forward the program."

Such nationalistic fervor could prevent Earthlings from ever reaching our red neighbor. Should the world's spacefaring nations overcome their instincts to go it alone, however, here's what a joint effort might lead to in the next 40 years

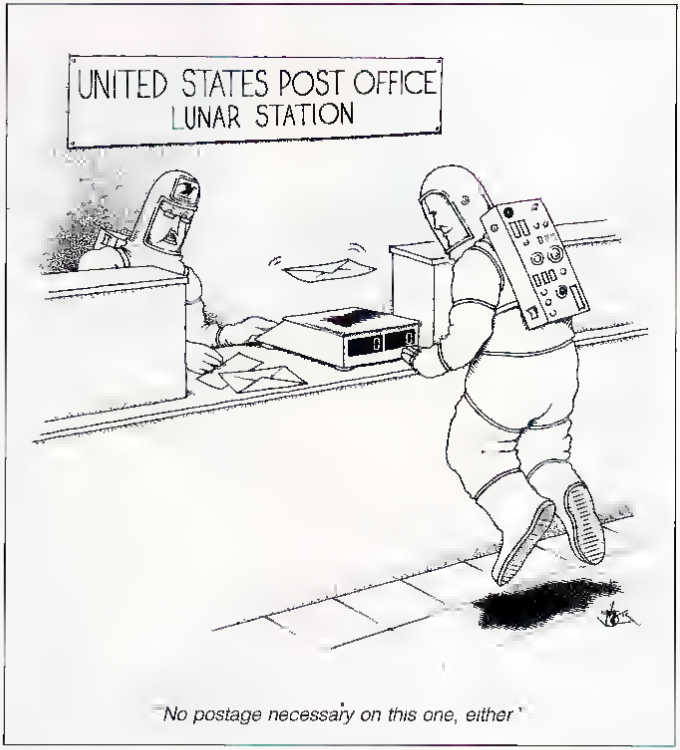
GOING MY WAY?

"Ten, nine, eight..." The mammoth rocket sits on the Baikonur launchpad deep in the south central region of the Soviet Union, poised to truck another 100 metric tons of hardware to low Earth orbit This is the twentieth such launch, and astronauts and cosmonauts in orbit are busily assembling all the payloads into a convoy headed for the moon. The booster is the Energia, pride of the Soviet launch stable and the biggest vehicle to rise from a pad since the Saturn 5 of Apollo days Indeed the two rockets are in the same class Energia can lift 220,000 pounds to low Earth orbit, the Saturn 5 lofted the 165,000-pound *Skylab*

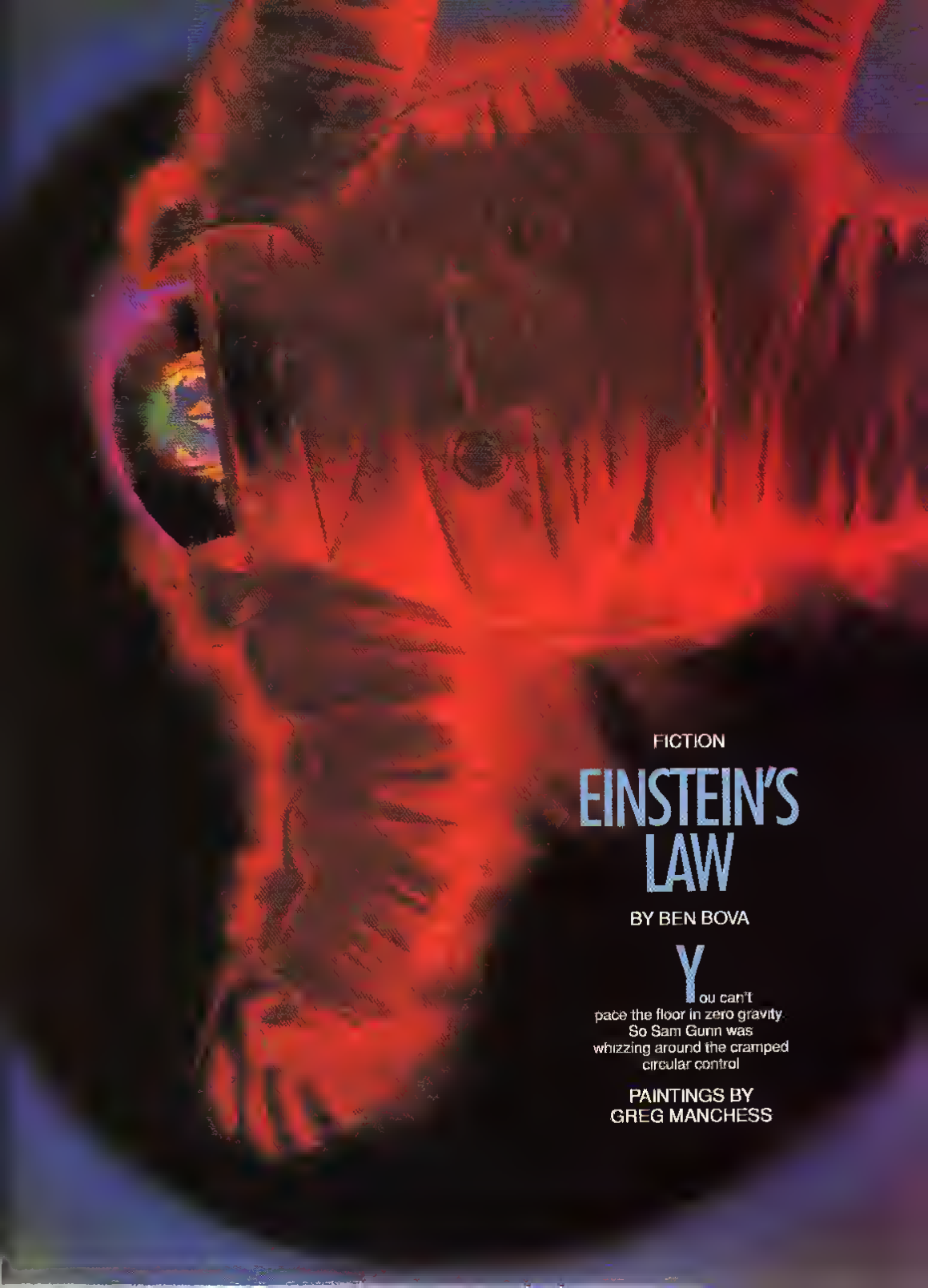
The first step to Mars, propelling thousands of tons of construction materials, rocket motors, spacecraft components, life-support systems, living modules, air, water, food, and humanity out of Earth's gravity well and into space. Neither the shuttle, with its 48,000-pound capacity, nor the biggest U S. rocket, the Titan 4, which carries 40,000 pounds to orbit, could deliver such a massive amount of equipment And what will be ESA's largest launcher, the Ariane 5, will lift only 46,200 pounds

Comparing the Mars mission's lift requirements with those of the space station gives some feel for the magnitude

CONTINUED ON PAGE 80



"No postage necessary on this one, either"



FICTION

EINSTEIN'S LAW

BY BEN BOVA

You can't pace the floor in zero gravity. So Sam Gunn was whizzing around the cramped circular control

PAINTINGS BY GREG MANCHESS

center of our ship like a crazed chipmunk, darting along medly, propelling himself by grabbing at handgrips, console knobs, viewport edges, anything that could give him e moment's purchase as he whirled by

I was sweating over my instruments Every nine seconds Sam whizzed past me like a demented monkey, jabbering, "It's gotta be there It's *gotta* be there!"

"There's *something* out there," I yelled over my shoulder, annoyed with him Angry at myself, really It was my calculations that had put us into this fix

The instruments were showing a definite gravitational flux, damned close to what I had calculated when I wes still back on campus But out here, well past the orbit of Pluto—farther than anybody had gone before—what I needed to see was a planet, a fat little world orbiting out in that darkness more than seven billion miles from Earth

Planet X The tenth planet Astronomers had been searching for it since before Lowell's time, but I had worked out *exactly* where it should be, me and the Caltech/MIT/Osaka-linked computers And Sam Gunn had furnished the money and the ship to go out and find it

Only it wasn't there

"It's gotta be there." Sam orbited past me again. "*Gotta be* "

The first time I met Sam, I thought he was nuts Wiry little guy Hair like a nest of rusted wire Darting, probing eyes Kind of shifty The eyes of a politician Or a confidence man

"Fly out there?" That startled me. "Why not just rent time on an orbital telescope or use the lunar observa—"

"To claim it, egghead!" Sam had snapped "A whole planet I want it "

He couldn't be that dumb, I thought He'd amassed several fortunes and lost all but the latest one To fly out beyond Pluto would cost every penny he had and more "You can't claim a planet," I explained patiently "International agreements from back in—"

"Puke on international agreements!" he shouted "I'm not a national government I'm S Gunn Enterprises, Inc And a whole planet's *gotta* be worth a fortune " Sam hed a reputation for shady schemes, but I couldn't for the life of me see how he planned to profit from claiming Planet X Nor any reason for me to leeve my home and job at the university to go out to the end of the solar system with him

I didn't reckon on Sam's persuasiveness He didn't have a silver tongue Far from it His language was more often crude than eloquent Even obscene But he was e nonstop needler, wheedler, pleader, seducer In the language of my forefathers, he was a *nudzh* His tongue didn't have to be silver, it was heavy-duty, long-wearing, blister-proof, diamond-coeted solid muscle

So I found myself ducking through the hatch of a special ship he had commissioned Only the two of us as crew I wes to do the navigating, Sam did everything else, including the cooking Before i could ask myself why I was doing this, I was being flattened into the eccelereation couch as we roared out into the wild black yonder

But Planet X wasn't there

Sam slowed down puffing, until he was dangling right behind me his feet half a meter off the floor My softboots were locked in the foot restraints and still he barely came up to my height He was wheezing and I realized there was a lot of gray in his reddish hair His face looked tired, old, eyes baggy and sad

"Just my luck," Sam groaned "Of all the eggheads in all the universities in all the solar system, you ve "

Suddenly I realized what the instruments were telling me I shouted, "It's a black hole!"

"And I'm the tooth fairy"

"No, really! It's not a planet at all It's a black hole Look!"

Sam snarled "How in hell can I see something that's invisible by definition?"

With trembling fingers I pointed to the gravitetional flux meters and high-energy detectors We even went over to the optical telescope, bumping heads like Laurel and Hardy, trying to squint through the eyepiece together Nothing to see Except a feint violet glow, the last visible remains of the thin interplanetery gas that was being sucked into the black hole on a one-way trip to oblivion

It really was a black hole The final grave of a ster that had collapsed, God knows how many eons ago A bleck hole! Practically in our backyard! And I had discovered it! Visions of the Nobel prize made me giddy

Sam sprang straight to the communications console and started tapping franticelly at its keyboard, muttering about how he could rent time to astronomers to study the only bleck hole close enough to Earth to see firsthand

"It's worth a fuckin' fortune " he chortled, his fingers racing along the keys like a concert pianist trying to do Chopin's "Minute Waltz" in thirty seconds "Lots of fortunes!" He filed his cleim and even gave the black hole a name Einstein I grinned and nodded agreement with his choice It took nearly eleven hours for Sem's message to get to Earth and another eleven for their reply to reach us I spent the time studying Einstein while Sam proclaimed to the universe how he was going to build an orbiting hotel just outside Einstein's event horizon and invent e new pastime for the danger nuts

"Space surfing! A jetpack on your back and good old Einstein in front of you See how close you can skim to the event honzon without getting sucked in! It'll make billions!"

"Until somebody gets stretched into a bloody string of spaghetti," I said "That gray field out there is *powerful* And I think it fluctuates "

"All the better," said Sam, clapping his hands like a kid in front of a Christmas tree "Let a couple of the risk freaks kill themselves and all the others will come bolling out here like lemmings on migration "

I shook my head in wonder

When the comm signel finally chimed, I wes still trying to dope out the basic parameters of our black hole Yes, I was thinking of Einstein as ours, that s what being near Sam does to you

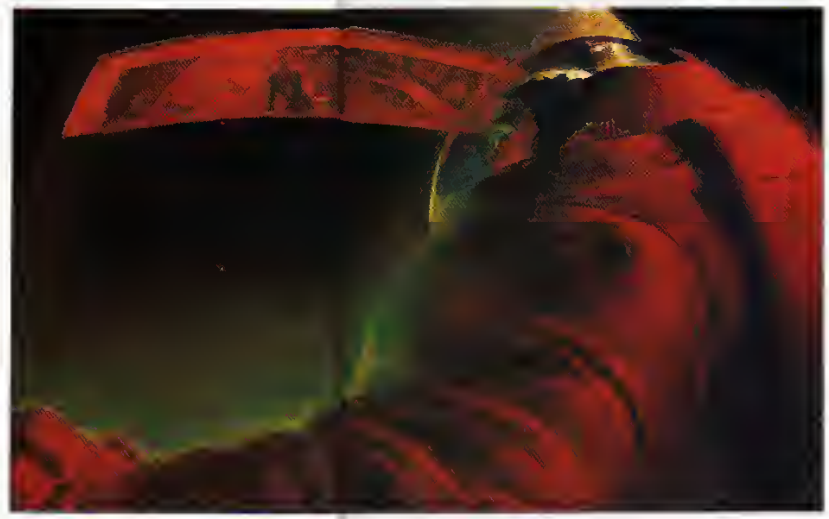
His round little face went pugnecious the instant he saw the woman on the screen I felt an entirely different reaction She was beautiful, with thick platinum blond hair and the kind of eyes that promised paradise

But her voice wes as cold as a robot's "Mr Gunn, we meet egain Your cleim has been noted and filed with the Interplanetary Astroneutical Authority In the meantime, I represent the creditors from your most recent bankruptcy. To date " She droned on while Sam's fece went from angry red to ashy gray This far from Earth, all messages were one-way You can't hold e conversetion with an eleven-hour weil between each transmission The blond went into infinite detail about how much money Sam owed, and to whom Even though I was only half listening, I learned that our ship was not paid for, and my own university was suing Sam for taking my instrumentation without authonzation!

Finally she smiled slightly and delivered the knockout " Now, Mr Gunn—aside from all the above unpleasantness, it may interest you to realize that your claim to this alleged black hole is without merit or substance "

Sam growled from deep in his throat

I ARGUED WITH HIM FOR AN HOUR WHILE HE GOT THE POD TOGETHER AND REVVED UP THE EVA. WHAT HE WAS DOING WAS DANGEROUS.



"Although international law allows one to claim the *use* of a body found in space the law clearly states that you must establish an operational facility on the body in question before such e cleim will be recognized "

Sam snorted like a bull about to charge Me, I thought about establishing an operationel facility on the body attached to that beautiful face

"So I'm afraid, my dear Mr Gunn"—her smile widened to show dazzlingly perfect teeth—"that unless you establish an operational fecility on your alleged black hole, your cleim is worthless And, oh yes! One more thing—an autometed ship is on its way to you, filled with robot lawyers who will heve authorization to take possession of your ship and all its equipment, in the name of your creditors Good-bye Have a nice day "

The screen went blank

Sam gave a screech that would make an ax murderer shudder and flung himself at the dead screen He bounced off and scooted weightlessly around the control center again, gibbering, jabbering, screaming insults and obscenities at the blond, the IAA, the whole soler system in general, and all the lawyers on Earth in particular

"I'll show,'em all!" he raged

"They want an operational facility, they'll get an operational facility!"

I wrenched free of the foot restraints so fast I twisted an ankle and went diving after him

"Sam, what the hell are you thinking of?" He was already unlocking the hatch of our EVA scooter, a little one-man utility craft with a big bubble canopy and so many extendable arms it looked like a metal spider

' I'm gonna pop an instrument pod down Einstein's throat We've got ta have our facility going before those tin can lawyers get here!"

"But it'll just disappear into the black hole!"

"So what?'

"Then it won't be an operational facility "

"How do you know what it'll be doing inside the event horizon? If the mother-humping lawyers want to prove that it's not working, just let 'em jump in after it And kiss my ass on the way down!"

We argued for more than an hour while he got the instrument pod together and revved up the EVA craft What he wanted to do was *dangerous* Maybe adventure freaks would like to skim around the event horizon of a black hole Me, I don't feel really safe unless there's good California soil shaking beneath my feet But Sam would not be denied Maybe he was a danger freak himself Maybe he was desperate for the money

"We gotte meke our claim stick," he kept muttering "It's our only chance!"

He didn't even put on a pressure suit He just clambered up into the cockpit of the EVA craft, slammed its hatch, and worked one of its spidery arms to pick up the instrument pod

Reluctantly, I went back to the control center to monitor Sam's mission

"Stay well clear of the event horizon," I warned him over the radio, "I don't know enough about Einstein to give you firm parameters "

Sam was no fool He listened to my instructions He released the instruments well clear of the event horizon But the pod just orbited around the faint violet haze that marked Einstein's position It didn't go spiraling into it

"Goddamn mother-humping no-good son of a lawyer!"

Sam jockeyed the EVA creft into e matching orbit and gave it e push inward Not enough Then another swearing a blue streak every instant

"That's close enough," I yelled into the microphone "The event horizon fluctuates, Sam You mustn't—"

I swear the black hole reached out and grabbed him The event horizon sort of burped and engulfed Sam's craft I know it's impossible, but that's what happened

"Hey!" he yelled "Heyyyyyy!"

According to everything we knew about black holes up to then, Sam was being squeezed by Einstein's gravitational forces, torn apart, crushed, mashed, squashed, pulverized

"What's going onnnn?" Sam's radio voice stretched out eenly, like in an echo chamber

"What's going on?" I asked back

"It's like sliding down e chuuute!'

"You're not being pulled apart?"

"Hell, nooo! But I can t see anything Like falling down an elevator shaaaft!"

Sam should have been crushed But he wasn't I started to laugh We had named the black hole exactly right Inside the event honzon space-time was being warped But Sam was now part of *that* continuum, and to him everything seemed normal Our universe, the one I'm in, would have seemed weirdly distorted to him if he could see it It had all been there in old Albert's equations, if wa had only had the sense enough to realize it Sam Gunn—feisty, foul-mouthed, womanizing, fast-talking Sem Gunn—hed discovered a shortcut to the stars, a space-time warp that one day would allow us to get around the limits of speed-of-light travel But Sam gave his life to his discovery He was on a one-way trip to God knows where Maybe there'd be kindly aliens at the other end of the warp to greet him and give him their version of the Nobel prize

I got the terrestnal Nobel, of course And now I'm heading up an enormous team of scientists who're studying Einstein and trying to figure out how to put black-hole warps to practical use

And Sam? Who knows where he is?

But you can still hear him, thanks to Einstein's time-stretching effects, swearing and cussing every moment all the way down that long, long slide to whatever's on the other side of the warp

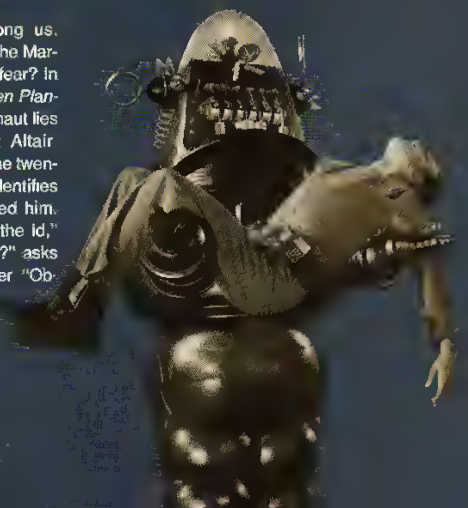
And according to Einstein (Albert), we'll be able to hear Sam yelling forever Forever Forever ∞

PICTORIAL

RAIDERS OF THE LOST ARCHIVES

Let the myth—shown at Saturday matinees across America—take the fear to the max, to what filmmaker Jean Cocteau called *la zone*—the site of fright. Simply portray fear of the Russians or nuclear holocaust through revengeful Martians about to destroy Planet Earth. Blow it up. Exaggerate it. Distort it. Make it nightmarish. Give us goose bumps. Then, maybe, we'll be able to walk out of the darkness where we've watched a B movie and feel some relief.

Does all this sound ludicrous? Our ancestors depicted *their* fears. Look at the cave paintings, stick figures pitted against avenging creatures about to destroy their world. Apparently, we've always handled fear in this way. Depict it, project it. A lesson here, perhaps. When we project our fear outside of ourselves, we can say, Hey, maybe the fear is ours, it's not really the Russians or the creatures that walk among us. Guess what? We are the Martians. Then what's to fear? In the 1956 film *Forbidden Planet* (page 44), an astronaut lies dying on the planet Altair Time: first decade of the twenty-third century. He identifies what mortally wounded him. "The monster's from the id," he says. "What's that?" asks the mission commander. "Obsolete term" once used to describe a structure in the psy-




BUCK ROGERS
LARRY "CRABBE"
COMMANDO CODY
SKY MARSHAL OF THE UNIVERSE
Robot Monster of MARS
MGM presents
FORBIDDEN PLANET
AMAZING!
INVASION OF THE SAUCER-MEN
EDWARD L. ALPERSON
INVADERS FROM MARS
COLOR
FANTASTIC SIGHTS LEAP AT YOU!
3-DIMENSION
AMAZING! EXCITING! SPECTACULAR!
IT CAME FROM OUTER SPACE
FLIGHT TO MARS
FIFTY YEARS INTO THE FUTURE!
EARTH GIVEN 24 HOURS TO SURRENDER!
INVISIBLE INVADERS
SPECTACULAR ADVENTURE BEYOND TIME AND SPACE
cinemagic
THE ANGRY RED PLANET
The screen's FIRST story of mans conquest of space!
ROCKETSHIP X-M
H.G. WELLS'
The War of the Worlds
COLOR BY TECHNICOLOR
H.G. WELLS' ASTOUNDING ADVENTURE IN
DYNAMATION!
FIRST MEN IN THE MOON
THE TIME TRAVELERS

che, Dr. Morbius explains. "We are all part monster in our subconscious. That's why we have laws and religion."

Oogah boogah.

Not sure we've got the message, though. Odd that the more rational we've supposedly become, the more we understand the laws of science, the more the monsters within multiply. And the blockbuster science-fiction flicks of the late Sixties, Seventies, and Eighties echo that theme: IT, The Terror From Beyond Space, becomes E.T., a gentle, curious thing, a peace guru of sorts, more humane than the people he encounters on Earth, wanting to teach us a better way. Like the star child in the closing shots of *2001* staring down on Earth's inhabitants. Is it hope we're supposed to feel? A hope that we will follow these creatures to make the next leap in consciousness?—Ed Wyckerson *The End*

FORUM

CONTINUED FROM PAGE 14

us to understand our own environment.

The benefits reaped from the technological breakthroughs needed to push man to another planet would have direct applications on Earth, just as the microminiaturization of space equipment improved our lives in numerous ways. These breakthroughs would not only fuel America's economy but create new business and jobs.

The question, as I see it, is not whether we can afford to explore Mars, but how long we can afford to delay this exciting, inevitable venture.

The Case Against Mars

Congressman Bill Green, Ranking Republican on the House Appropriations Subcommittee which funds NASA

Last year, on the twentieth anniversary of the landing of Apollo 11 on the moon, President Bush called for a return to the moon and a manned mission to Mars. Although he wanted this speech to have the same propulsive effect on the national will as President Kennedy's 1961 speech, it clearly has not. It is not that Bush lacks the ability to inspire, but rather that there are other important reasons why the moon–Mars mission is not the right idea now.

That mission, spread over its lifetime of 25 to 30 years, will cost more than half a trillion dollars. Yes, as a percentage of gross national product it's slightly less than the Apollo program, but Senators Gramm, Rudman, and Hollings were unheard of in the Sixties, and the annual deficit ranged from $507 million to $27 billion, a fraction of both today's deficit of $161 billion and the annual interest on the national debt, which is $180 billion.

In the Sixties the race to the moon was virtually the only item on NASA's plate. Today we have the $30 billion space station, Mission to Planet Earth—a series of unmanned platforms to monitor environmental changes on Earth—which I consider to be NASA's highest priority, the great observatories and planetary-probe astronomical programs, and the existing shuttle program. This will assure the agency of a healthy annual increase throughout the Nineties.

What are the compelling reasons for a mission to Mars? From a scientific standpoint, we can do most of the science we want from unmanned probes—witness the spectacular success of the *Voyager* satellite. Unmanned probes not only would be cheaper, but the science they could do would not be compromised by the intrusion of man.

There are those who promote the Mars mission as the logical extension of mankind's desire to explore the unknown, to "go where no one has gone before." I do not disagree with that notion, but I do think that since we have done such a good job of fouling our own nest, perhaps we should look to those needs first.

The National Academy of Sciences' recent report *Human Exploration of Space* has been used by some as support for the Mars mission. It should be pointed out, however, that the report, as requested by Vice-president Quayle in his role as chairman of the National Space Council, began from the premise that a manned moon–Mars mission was a national goal. The report, therefore, never addressed whether it should be a national goal. That goal has yet to be agreed upon in Washington and is also the subject of active dispute in the scientific community.

Last year the vice-president invited me and about a dozen other members of the House and Senate most active in space policy to the White House to get a preview of the plan. I think I can charitably characterize the response to the proposal as mixed. For many of us, NASA has many more important roles. For this member, the mission to Mars is the last float in the parade. ∞

LATTER-DAY MARTIAN CHRONICLES

PAINTINGS BY GREG MANCHESS

Working, living, and loving—authors Isaac Asimov, Pat Murphy, Bruce Sterling, Joan D. Vinge, and Gregory Benford show us a day in the lives of the red planet pioneers

Consider the following scenario: The Vice-President of the United States chairs a group to plan the country's space future. It reports on three possible long-range programs. The first is a mission to Mars that will put men on the red planet in two decades, the second proposes orbiting lunar and space stations and a shuttle, and the third keeps costs down by suggesting just the space station and the shuttle.

Sounds pretty much like today's news, doesn't it? Surprise: The VP in question was Spiro T. ("nattering nabobs of negativism") Agnew, and the space task group he headed made its report in September 1969. Had we followed its most ambitious advice, American astronauts would now be dwelling on a distant planet.

While the flagging courage of our pundits and politicos thwarted such a grand vision, *Omni* has decided to draw a picture of what life would have been like for the Martian colonists had such a commitment been made. Think of it as an alternative reality—what might have been had we spent an extra $10 billion a year on the space program over the last two decades. Had we made this investment, mankind would have settled Mars in 1985 (year 1, Tempus Mars).

To report back to Earth about life on our planetary neighbor we have enlisted the aid of writers Isaac Asimov, Pat Murphy, Bruce Sterling, Joan D. Vinge, and Gregory Benford. From their vantage points they depict a place where the living is exciting, the going hard, and the potential unlimited. —Tom Dworetzky

Dear Mabel:

Well, here we are, as promised. They've given us a permit to live in the Valles Marineris, and don't think we haven't been waiting for a year and a half because we have. They're so *slow* and they keep talking about the capital investment required to make the place livable. Valles Marineris sounds good as an address, but we just call it the Canyon, and I don't know why they're so worried about its being livable. It's the Martian Riviera, if you ask me.

In the first place, it's warmer down here than it is in the rest of Mars, a good ten degrees (Celsius) warmer. The air is thicker—still thin enough, heaven knows, but thicker and a better protection against ultraviolet.

Of course, the main difficulty is getting in and out of the Canyon. It's four miles deep in places, and they've built roads here and there so that you can get down in special mobiles. Getting up and out is more

difficult, but with gravity only two fifths what it is on Earth, it isn't as bad as it sounds, and they do say they're going to build elevators that will take you at least partway up and down.

Another problem is that dust from the storms does tend to accumulate in the Canyon more than on the ordinary surface, and there are landslides now and then, but heavens, we don't worry about that. We know where the faults are and where the landslides are likely to occur, and no one digs in there.

That's the thing, Mabel. After all, everyone on Mars lives under a dome or underground, but here in the Canyon, we can dig in sideways, which I understand is much preferable from an engineering standpoint, though I've asked Bill not to try to explain it to me.

For one thing, we can heat out some of the ice crystals, so that we don't have to depend on the government for *all* the water we need. There is more ice down in the Canyon than elsewhere. And for another, it's easier to manufacture the air, keep it inside the diggings and circulate it when you're in horizontally instead of down vertically.

That's what Bill says.

And I've been thinking about it, Mabel. Where's the need to leave the Canyon, anyway? It's over three thousand miles long, and in the end there are going to be diggings all along it. It's going to be a huge city, and I'll bet you most of the population of Mars will end up here. Can't you see it? There'll be some kind of meglev rail running the length of the Canyon, and communication will be easy. The government ought to put every bit of money it can into developing it. It will make Mars a great world.

Bill says (you know what he's like—all enthusiasm) that the time will come when they will roof in the whole Canyon and instead of having air just in separate diggings and having to put on a space suit when you want to travel about, we will have a huge world of normal air and low gravity.

I said to him that the landslides might break the dome and we would lose all the air. He said that the dome could be built in separate sections and that any break would automatically shut off the affected areas. I asked him how much all that would cost. He said, "What's the difference? It will be done little by little, over the centuries."

Anyway, that's his job here now. He's got his master's license as an areo-engineer, and he's got to work out new ways to make the Canyon diggings even better. That's why we got our new place here, and it looks as though Mars is going to be our oyster.

We may not live to see it ourselves, but if our great-great-grandchildren make it to 103 TM, a century from now, we'll have a world that may well overshadow Earth itself.

It would be wonderful. We're very excited, Mabel.

Yours,
Gladys

—By Isaac Asimov

Endurance Station, Northern Polar Cap, Mars
March 44, 43 TM

Dearest Nicholas,

We leave in a few hours. The others are still asleep, but I woke up an hour ago. With luck and continued good weather, we'll reach the far side of the polar cap in just over a month. We'll be the first to cross the pole, the first to map the hidden lands that lie beneath the ice. How can anyone sleep?

Yesterday we drew lots. For the first leg of the trip, Paul and Yuri will drive the Sno-Cat that tows the jumping truck. Sita and I will tow the Caboose, the ungainly box that will serve as our living quarters. I've stashed the bottle of French champagne you gave me in my duffel and I'll break it out when we reach the North Pole.

I'm eager to get under way. The confinement of the station is getting on my nerves. We have ten researchers in a space meant for six, and tempers are wearing thin. The constant rumbling of the drilling rig shakes the ground. Sure, the core samples will provide valuable information about the Martian climate over the last few thousand years—but right now I'd trade all that for a good night's sleep. The air of the living dome reeks of yesterday's dinner. My pressure suit reeks, too—the stale stink of yesterday's sweat—but at least that's my own personal sweat. Besides, the view through the faceplate makes it all worthwhile.

Yesterday, at sunset, I climbed a hill near the station. The setting sun painted the salmon-colored sky with streaks of brilliant green and pale blue. Beyond our tiny cluster of buildings, out across the vast ice fields, massive ice cliffs rose from the snow-covered plain. The cliff faces were streaked with red, the legacy of long-ago dust storms.

Below me I could see Sno-Cat tracks from last week's reconnaissance mission. Yuri and I towed the jumping truck out there, powered up the flywheel, and watched as the truck thumped the ground vigorously, sending sound waves through the ice to echo from the bedrock below. The array of geophones that we had placed near the station recorded the echoes. Computer analysis revealed a network of interlocking canyons two thousand meters beneath our feet, a secret land that no human eyes have ever seen. By the time we're done, our map will show all the secret valleys, the hidden peaks beneath the ice.

We joke sometimes about what we will find out there. On the wrapping that covers her book of satellite photos, Sita has delicately penned, HERE BE DRAGONS. Sita promised we will find the tracks of the yeti in some distant canyon. The snowfields, she said, remind her of the Himalayas, where she grew up. We laughed with her. "What did they eat, these yeti?" I asked. "That is, before we came along." She smiled. "They feed on dreams, of course," she said. "That is always what hes sustained the yeti."

Standing up there, looking out toward the cliffs, I could almost believe in Sita's yeti. I thought I saw something moving, out there in the middle of the ice field. A trick of the light, I know. Out here a smudge of frost on your faceplate can become a shape that moves with each turn of your head. The shadow of a wind-etched hummock can take on solidity. I know that, but in this cold and lonely place, it is hard not to believe in shifting shadows and fantastic creatures.

The sun went down and I heeded back to camp, following the path of my own bootprints. The beam of my headlamp glittered on the carbon dioxide frost that forms each night. As I walked I found myself studying the bootprints carefully, as if I expected to see something different. Another kind of print, perhaps. But I found only my own tracks.

Back at the station the living dome was fragrant with curry. Paul was cooking our farewell dinner. Yuri was repairing a strap on his pressure suit. Sita was examining her charts. Thoughts of yeti fled, banished by the warmth and light and companionship. But when I slept, I dreamed again of the yeti. Their long white fur was streaked with the rusty red of Martian dust, and they watched me with eyes as black as the sky at night. Silently they slipped through caves of ice, making their way to the hidden lands beneath the snow and daring me to follow.

In just a few hours I will follow them. We have your bottle of champagne to drink at the North Pole, when we find it. And we have dreams. Somehow that seems like enough. Wish me luck.

Love,
Maria

—By Pat Murphy

FROM: OFFICER YANO, INCIDENT IN VALLES MARINERIS COLONY COMPLEX, 3/10/3 TM

Fridays are often bad in the arcade. The Japanese personnel, the vast majority here, are proud to work six full days a week. But the American miners are released every Friday for two days of trouble and uproar. Our colony's corporate board has forbidden liquor to the rough and unruly miners, but their elaborate computer simulation rigs seem to affect them more strongly than drink. Last Friday I witnessed six miners, just off work, bounding and tumbling wildly down the shopping arcade, howling, stumbling, and waving their arms. The colony's rail launcher was firing a cargo of ore at the time, creating a tremendous rumble that shook the colony from end to end, like a Tokyo earth tremor. It is true, as the miners protested afterward, that no one could actually hear their rude bellows and foul cursing in the English language. Nevertheless, the arcade owners and shopping colonists could witness them publicly misbehaving, and this was unnerving. The dress of the miners is deliberately provocative. Unlike the rest of us, the miners sport rough American pioneer garb: "coonskin caps" (of simulated nylon plush) fringed "buckskin" jackets (of tattered brown vinyl). They rather neglect their personal hygiene

"The Canyon's over 3,000 miles long, and I'll bet you most of the population of Mars will end up here. Bill says someday they will roof in the whole Canyon."

"The large miner had been linked to a mining robot for 12 hours and he was still confused, he tried to swat me aside, as if his strength were still gigantic."

and sport long, stringy hair and bristling beards. Their faces are ferociously blackened, too—their eyelids sprayed daily with a black antiglare grease, then streaked with sweat from their long hours clamped under the videophones.

I would never deny the Americans their ethnic self-expression. Still, this rough clothing looks quite ridiculous on the soft, pudgy bodies of the miners, who spend all their working hours lounging in fat-padded chairs with their eyes, ears, and arms entirely swathed in robot tele-operating rigs.

When I chided the miners for their rudeness, one of them, the large one named Maknamara, actually attacked me—clumsily swatting at me with his bare, clawed hands. He had been linked to a mining robot for twelve hours, clawing up ore in a canyon hundreds of kilometers away, and he was still confused and tried to swat me aside as if his strength were still gigantic. But his normal reflexes and perception were warped and distorted, for he missed me completely and almost fell down. I subdued him swiftly with a grappling throw, though in the light gravity he was scarcely harmed. The others, in foul English and worse Japanese, began to curse me and to curse our snug colony, with its tight-sealed walls, tasteful decorator pastels, and (as they say) cramped spaces. And they raved about gigantic canyons, and painted deserts, and buttes, and mesas, and arroyos, and other terms equally alien. They screamed that they were "the only real pioneers," and the only colonists among us who were actually "experiencing Mars at all."

Maknamara was fined, though the other miners treat him as if he were a hero. Doubtless there will be more trouble in weekends to come. But the situation might be worse, for in their own queer way the miners do seem to care sincerely about their work. On Monday morning they were all safely back in the world-wrapping grip of their televisions.

—By Bruce Sterling

PDR INDUSTRIES 347 600943 LPK@ *CANTU*
FLIGHT LOG 17 JUNE 3 TM
AGENT R F X BRODY
REPORT ARRIVED MARS LAURENCE/PETROV BASE
16 13 HOURS LOCAL TIME
BEGAN CARGO OFFLOADING PROCEDURE REMANDED HIJACKERS TO AUTHORITIES

LINKNET ACCOUNT 45467311MARS
PERSONNEL R O DONNELL
SEND SHIPBOARD MAIL *CANTU* REG PDR INDUSTRIES
TO SERINA BRODY
4355 APPLE MEADOW LN

CAXTON HUB OH 346559008 USA
LINKNET 975408921USA

DEAR SERINA BRODY
I HAVE KNOWN YOUR HUSBAND FOR A LONG TIME NOW AND THERE IS SOMETHING I HAVE TO TELL YOU, BECAUSE I KNOW HE WILL NEVER TELL YOU HIMSELF

"How did you do it, Brody?" she asked, doing her best to appear noncommittal. He hadn't said more than five words about the hijacking at the docks. The pedestrian tunnel between the shipping area and her office was not crowded, but she saw the tension furrowing his brows, under his unkempt dark hair. He needed a haircut. He stank. He hadn't seen another human being in three months. He glanced at her, avoiding her eyes, looking at her uniform, as if he was reading the patch on her pocket. R. O'DONNELL, SECURITY. He knew what it said. He was looking at her breasts. After all this time she knew the signs.

He shrugged. "I hit one with a wrench. I took his gun and told the rest I could blow up the ship if I fired it. Then I locked them in the hold. They believed me, the stupid bastards. I thought crooks were only stupid in the vids."

"Don't kid yourself," she said. "That's all?"

He shrugged again. His eyes were blue. She thought of Earth's skies.

They reached her office. She shut the door. She locked it. And then he was holding her, so close she could feel every bone in his body bruising her. "Rosie..." he said into the red curls behind her ear, "I thought I was dead. I thought they were gonna kill me."

Her nails dug into his back, she kissed him, openmouthed, as he pushed her up against the wall. The floors of Laurence/Petrov Base were metal, as cold as ice. The walls looked solid, but there was only compressed air behind those smooth, faintly yielding surfaces. Her frantic hands unfastened his pants. "Oh, Rick, oh, Rick..." She said his name like a prayer as his fingers slid inside her shirt. For fifteen minutes, up against the wall, she forgot to mind that she was living in a balloon.

YOU NEVER SEE THE RICHARD BRODY THAT I KNOW OUT HERE HE IS A DIFFERENT MAN

"Unbelievable," he said, half wondering and half incredulous. They lay side by side on the warm sand, feeling the cool waves kiss their feet. "Free beers for three days. Player credit in the rec center. And now we have the beach to ourselves." He squinted at the sun, high overhead in the blue dome of sky.

"Word got out, rocket man. More than two hundred people here now, but still no secrets." She stretched blissfully.

"This's all because of the hijacking?"

"The attempted hijacking."

"They're that glad I saved my ass."

She leaned to kiss him. "I am. All they care about is the supply shipment. And the fact that somebody tried to take your ship at all, which means we're important enough to have something worth stealing. The media on this will be great!"

"Shit." He sat up frowning. "Don't start."

"It's important to us here. To me. It's our survival at stake. I went you to do a tape—"

"I went you," he said, pulling her over on top of him.

"Don't change the subject." She resisted halfheartedly and then gave in, still hungry after three days. A wave broke around them, she imagined she heard flesh sizzle.

"No secrets here, huh?" he whispered afterward. "Not even when we're all alone?" His hand caressed her cheek. She saw his wedding ring in the light.

"Just you and me and your wife," she said, suddenly restless. "How are the kids, Rick? Did Johnny's sim team make it to the environment play-offs?"

He sighed, she felt his frown come back. "What do you want from me, Rosie?"

She held him, kissed him with fierce longing. "I want to be your wife—"

"You had your chance." He sat up, pushing her gently aside. He touched the control box, and they were sitting on the floor in the empty environment cubicle again, so suddenly that the change brought tears to her eyes. He got to his feet behind her, pulling up his trunks. "You wanted this." He gestured at the far wall. Beyond a transparent panel the south polar ice cap shone, a fragile film of white on a field of relentless rust. "You can't raise a family here." He looked back at her, with eyes as bleak as the view.

She blinked the humiliating burn of tears from her own eyes. "Well, then," she said wearily, "will you make a tape for the media?" Knowing how he felt about this place, knowing that facing down hijackers was easier for someone like him than facing a media crew, still she had to ask it. "For me?"

"No," he said.

"Damn you—" She broke off. "You know we need news! We *are* making progress! In another twenty years, mining will make us economically viable—"

"Laurence/Petrov," he said bitterly, "The Town That Wouldn't Die."

"You selfish prick."

"That's all you ever wanted from me." He was already turning away. He left the room.

She stood with her arms folded across her breasts, staring out at the ice fields, the ruddy alien sky.

YOUR HUSBAND IS

She stared at the screen, as she had been staring at it all day, unable to finish the final sentence. She rubbed her eyes and took another gulp of warm beer. The apartment doorbell rang. "Who is it?" she asked, and a corner of the screen showed her his face.

"You changed the lock," he said.

"Rick?"

"Brody hadn't said more than five words about the hijacking at the docks. He needed a haircut. He stank. He hadn't seen another human being in three months."

"Will you marry me, Rosie?" He sounded drunk
"You're already married"
"Then can I come in?"
She tried to see whether there was anything in his hand. A tape, maybe, about the hijacking. She couldn't see anything. She sighed and opened the outer door. "Come on in, Rick."
YOUR HUSBAND IS. She stared at the screen. She put her hands to the touchboard. A HERO TO THE CITIZENS OF MARS. She pressed SEND before she could change her mind.

PDR INDUSTRIES 347 600943 CPK@ *CANTU*
FLIGHT LOG 31 JUNE 3 TM
AGENT R F X BRODY
REPORT DEPARTED MARS LAURENCE/PETROV BASE
08 00 HOURS LOCAL TIME WITH FULL CARGO
COMMENTS

—By Joan D. Vinge

FROM BIOENGINEER CHIEF CLAY
TO DR SANDERS OASIS CRATERS INC (ONE-WAY VOICE TRANSMISSION MARS–EARTH COMPRESSED SQUIRT)

It worked like a charm, sir. The orbital guys brought the icesteroid right in on sked. How they can deliver ice hunks the size of a football field, clear from the rings of Saturn, and drop them smack on target on Mars, I dunno. But they did.

You shoulda seen it! Like God got mad and finally put His foot down. The icesteroid blasted a hole a kilometer wide. We were hunkered down in a bunker way over the horizon, and I still couldn't hear right for an hour. They took three hole punctures at the dome in Hellas Central, and that's five hundred klicks away.

That bioteched dog you sent us was the first out onto the plain to watch the show. He scampered around in the streams and mud, yapping and carrying on. We sure liked him, sir, and we think he's the forerunner of a whole line of products that'll really hit it big here.

I was in the first tractor that reached the lip of the crater. It was just like you'd said in the brochures—all the subtundra ice melted, big pretty yellow geysers, mud flowing like chocolate rivers. I got good footage. Lassie—that's the dog—took off, those big lungs sucking in the oxy and nitrogen liberated by the impact. Frisked, barked—one of your best beasts, sir.

We got right to work rigging the plastic projectors along the crater rim. Took a day, but when we sighted them in and blew the bubble, it worked fine, just fine. The crater was still outgassing real well, so we just let it fill the bubble, pull it tight. Lot faster than when we blew the Hellas Central dome, I tell you.

So then we spread the biomat, just like you said. That blue algae stuff flat out loved the fog bubbling up everywhere. Had to throw down a patch and step back quick, 'cause it grew fast as it could eat.

Just sopped up the UV and gorged on the free chemicals. Beautiful white geysers spewed up like fountains all over the floor of the crater. That watered the mats even more.

And you were right about the rocks, too. I could feel the heat through my glove. That impact warmth made the biomat grow like crazy. In two days those patches of yours spread out and covered the whole crater. We got clouds forming at the top of the bubble dome, and then rain—the first on Mars in a couple billion years.

Right now we're sowing that new wheat you sent. Looks like a good product, uses the UV real well. Planted a field right next to the central lake. I figure we got a century's worth of water here, all from tundra ice. Dome pressure is half an Earth atmosphere. I can walk around in just long johns and an oxy mask. Yesterday at sunset we got an actual rainbow inside the dome, both ends standing on the crater rim.

"Lassie took off, those big lungs sucking in the oxy and nitrogen liberated by the impact. One of your best beasts, sir."

So I figure it's an unqualified success, sir. You can see that from the attached data. Time to franchise the operation, I'd say. I hope those Saturn ring guys can deliver a hundred or so icesteroids per year, 'cause we can blow bubbles for that many right now—and you just wait'll the whole crater oasis idea catches on!

Well, almost unqualified. We lost track of Lassie in all the rush. I figured, *Hell, where can he go, right?* He ran off into the crater, happy as any bioteched beastie I ever saw. But when I called Lassie, he didn't come. We were having trouble with the biomat then, so I got busy.

Thing was, it was *too* good. Gobbled up mud and grew, spreading like a carpet everywhere. Could hardly beat the thing off with a stick. Thick, too. Wearing steel boots, I walked over it like it was a rug, looking for Lassie.

So maybe you're going to have to do some fine-tuning on the mat. Or on Lassie 2, assuming there'll be an update in that product line.

We finally found out what happened to Lassie, sir, and I want you to know all of us here are real sorry. We don't like to lose equipment. After all, that cuts into our profit sharing, too.

But I'm afraid, sir, that the rug ate your dog.

—By Gregory Benford

INTERVIEW

SANDRA FABER

The Great Attractor, thousands of galaxies 150 million light-years away, says this astronomer, is pulling us toward it

PHOTOGRAPH BY ROB LEWINE

Winds blow cold across the summit of Mauna Kea, a dead volcano rising 14,000 feet from the big island of Hawaii. Far below, puffs of clouds hang in calmer air. The domes of nine observatories, sprung up like mushrooms from the bleak landscape, are shuttered against the sun. But one is open. From it drift the sound of rock music and the periodic report of an air-driven impact wrench. Astronomer Sandra Faber is here to view progress in constructing Keck, the world's largest optical telescope. Red lava rock crunches under her feet as she walks around the glossy-white building she helped design. "I insisted on this door," she says, adjusting her hard hat at the entrance to the telescope control room. "At other observatories I have to climb down two flights of stairs to see if it's clear. Here I'll just step outside." She laughs and looks up at the pristine sky.

Faber stands ready to use two radical new telescopes that promise to make this decade the most revealing ever in astronomy. As cochair of the Keck Observatory science committee, she will be among the first to point a ten-meter mirror at the night sky. As a member of the wide-field camera design team for the Hubble Space Telescope, she will share in 300 hours of coveted viewing time. She will find galaxies so far away and back in time that she can test her theories on how they formed in a universe of cold dark matter.

That Faber is poised to solve key problems with the newest telescopes at the right moment is no surprise to colleagues. As an astronomer and professor at Lick Observatory, University of California at Santa Cruz, she is known as the consummate opportunist. For years she declined to take sides in the argument raging over dark matter. In 1979, decid-

ing that the facts were in, she and Jay Gallagher, then a University of Illinois astronomer, wrote one of the most influential astrophysics papers of the time. It virtually proved that invisible matter makes up nine tenths of the universe. Widely regarded as an observer, she took her first stab at theory when she was thirty-six, at the first Vatican cosmology conference in Rome in 1981. In the company of such giants as Cambridge physicist Stephen Hawking and Nobel laureate Steven Weinberg, Faber said scientists could discover properties of the early universe by learning how galaxies form.

"Galaxies can properly be described as the building blocks of the universe," Faber says. "We think they are the first coherent structures to form out of the Big Bang." In the beginning, goes current thinking, a space the size of a quark—of almost unthinkable density—suddenly inflated faster than the speed of light to something about the size of a softball. Within it, quantum fluctuations, subatomic particles in paroxysms of energy and motion, created seedlike cores that ultimately evolved into galaxies. Dominating this process was the same matter that still composes 90 percent of the universe—the undetected dark matter. Most cosmologists thought this original matter was made up of tiny particles called neutrinos. But Faber had seen computer simulations of a neutrino universe. It showed galaxies forming into many layers of thin walls. Through her telescope she saw another universe entirely.

In 1984 she introduced the now-standard theory of dark matter with theoretical physicist Martin Rees of Cambridge as well as particle physicist Joel Primack and astronomer George Blumenthal, both of Santa Cruz. Invisible matter, they said, consisted not of neutrinos, which were considered "hot," but of "cold" dark stuff. These were massive, weakly interacting particles that clumped and clustered together to much later form the majestic galaxies spinning through space.

Ironically, Faber and six other astronomers, known as the Seven Samurai, later made a discovery that challenged their own cold dark matter theory. They observed a vast clustering of tens of thousands of galaxies 150 million light-years away, which became known as the Great Attractor. By the force of its gravity it seems to be pulling other galaxies toward it. Even our own Milky Way is streaming toward it at 1.3 million miles an hour, the Great Attractor's force slowing the outward expansion of this huge area of the universe. But their cold dark matter theory said this clumping should not occur on such a grand scale. Still confident that she is on the right track, Faber is mulling over a startling new idea that dark matter consists of two new particles, one massive and one light. A new computer model of this brew predicts clumping on a grand scale, matching her observations. Astronomers are now searching the microwave background—an afterglow of the Big Bang—for evidence of the tiny fluctuations that gave rise to galaxies. If these are detected, the inflationary Big Bang theory lives; if not, it dies. Cosmologists such as Faber intend to prove how it all began.

Born in Boston and raised in the Midwest, Faber was trained at Swarthmore College in Pennsylvania and at Harvard University. She joined the UC Santa Cruz faculty in 1972 and is among the few women elected to both the National Academy of Sciences and the American Academy of Arts and Sciences. She is, according to one colleague, fearless, confident and competitive. Interviewer Paul Bagne experienced that competitive force in a game of Ping-Pong at the astronomers' dormitory on Mauna Kea. "Stand back!" Faber ordered, ready to serve. "There's not as much gravity at this altitude."

Omni: What do you expect to discover from the Keck telescope?

Faber: Sometimes to solve problems in astronomy we simply need to see more detail. For years we thought the very bright Beta Pictoris was a pretty boring star. Then we got infrared pictures showing a disc of dust grains orbiting it rather like planets in our solar system. Then with a satellite infrared telescope we saw a giant disc around the very bright star Vega. Scattered along the arms of the Milky Way are dark knots of gas and dust. Within these clouds we think pockets of gas are collapsing under their own gravity, shrinking and spinning and finally igniting as new stars. Often a disc of dust bits is left behind. We think they coagulate into objects that grow into planets.

There may be more planets in our universe than there are stars! Our solar system is probably typical, with small rocky planets in the middle and big gaseous ones farther out. I think Mars was a little too small to hold its atmosphere and just missed being habitable for life. If we could see through the clouds around a young star we could see planets forming. In the infrared, the ability to make a sharp image is not affected by the atmosphere, only by the size of the mirror. Keck will give infrared images two or three times sharper and with finer detail than any existing telescope. I will go out on a limb and say that Keck will be the first telescope to find absolute, undisputed evidence of planets around other stars.

Omni: When did you first become interested in astronomy?

CONTINUED ON PAGE 86

Since you have a copy of Omni in your hands we can predict (scientifically, of course!) that you also have a big interest in the world of computers.

So we take great pleasure in announcing the newest addition to General Media Publishing's family of magazines: COMPUTE.

COMPUTE will be bigger and better than ever because it will combine four magazines into one. Along with COMPUTE, you will get COMPUTE's PC, COMPUTE's Amiga Resource, and COMPUTE's Gazette. So, in addition to all the MS-DOS tutorials, home office reports, programming tips, educational strategies, product reviews, and entertainment news COMPUTE is famous for, you now will find all the latest about IBM, Tandy, PC-compatible, Amiga, Macintosh, Apple, and Commodore computers. All written in the easy-to-understand, lively style you've come to expect from COMPUTE.

As an Omni reader and member of our publishing group, we'd like to give you a chance to subscribe to the new Compute at the lowest possible price – $9.97 for 12 issues. Prices will be going up, so act now and ENTER the world of computers.

COMPUTE DISCOUNT CERTIFICATE

☐ **YES!** Send me one year (12 issues) of COMPUTE for only $9.97! That's a savings of $25.43 (71%) off the newsstand cost of $35.40!

Name _____

Address _____

City _____ State _____ Zip _____

SEND NO MONEY NOW, WE'LL BILL YOU LATER!

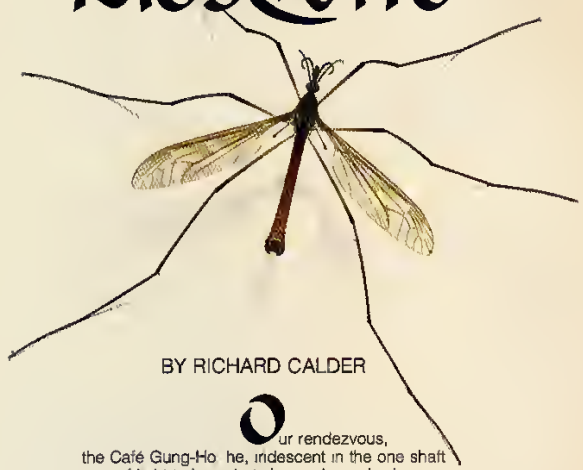
The regular subscription price for 12 issues is $19.94. Canada and elsewhere add $4.00, payable in U.S. funds only. HFMN4

Mail to: COMPUTE, PO. Box 3244, Harlan, Iowa 51593

FICTION

A Bangkok thief is hired to steal the perfect living doll

MOSQUITO



BY RICHARD CALDER

Our rendezvous,
the Café Gung-Ho he, iridescent in the one shaft
of light to breach its happy hour shade,
and I, seeing that beauty for the first time, poised
in the doorway, thinking, *Fatal, oh so fatal*

PAINTING BY BERNARD DURIN

ONLY A MAN COULD IMITATE A DOLL. FOR DOLLS ARE NOT WOMEN; THEY ARE MAN'S DREAM OF WOMEN.

The bar was deserted, save Harry, a few girls (humans, no gynoids Harry is a purist) and the radiant one—tall, blond, and cobra-eyed Breathless. I stepped into the light. Dressed like a man. I tried to walk like a man. But I was restive; I wanted to flirt. My alter ego, imprisoned by day within this safe-house of masculinity, rattled the bars of her cage and sulked.

"Kuhn Harry. I sorry," I said in my best Charlie Chan. "Zipper not tell me you want I come straight here." We assumed our roles. I played the all-purpose Oriental, Harry, the street-smart Brooklyn babe to whom, far from home, unsure of yourself, you could confess your appetites and trust your money.

"Yeah. Don't worry about it. Lord Chandos here don't want to hear about Zipper." I had abandoned myself to Milord's bodice-ripping eyes. Harry, who was acquainted with my schoolgirl crushes, briskly continued, "Let's talk business," and ordered drinks. I made the *wai*, sat down, a Mekong appeared before me.

"Lord Chandos wants to take a girl back to London." The boss paused for sales-pitch effect. "A *dtook-gah-dtah*." Of course. Why else was I here? Milord wanted a windup toy, a doll. I stole them, Harry fenced them. Our customer—despite the insistence of his beauty—was just another *farang* exhausted by human love, one whose lack of credit had led him east to seek the services of a rustler. But what beauty it was, a beauty from the land of ice and snow where, once, I had been happy.

"*Dtook-gah-dtah?*" I said. "No problem. My specialty. What kind of girls you like, sir?"

"Bad girls," he said, deadpan. "And call me James."

"Yes, Mr. James. Cartier? Rolex? Tiffany? All fake, of course. All imitation. But very good quality. Very reasonable price."

"Harry tells me half a million gets me Cartier."

"You have good taste. Cartier doll very nice. Very Deco. Very bad. But doll have no right, no civil status. You need passport or you never get her out of country."

"Passport's my department," said Harry. "It'll need a visa, too. I do both for two hundred thousand baht."

The Englishman sighed. "I'm no longer a wealthy man, Harry." Sweet *farang*, I could believe it. You seemed one of those ruined European aristocrats who, impoverished by debts, sought out cheap imitations of the toys to which they had become addicted but could no longer afford. Automata were the playthings of the rich, but here in sex city (where the boys are so pretty), city of angels, dolls, and of night, we fake everything—TVs, software, designer jeans, life.

"In all world," I said, "you cannot get better price. And anyone tell you, Mr. James, Thai lady dolls number one."

"We're putting ourselves at considerable risk. Apart from the trouble of lifting a doll, the Eurobunnies—sorry, James—are down on us for copyright infringement. Someone out there has killed three doll rustlers this month alone." Our customer looked uncertain, and Harry proceeded with the hard sell. "Mosquito's just amazing. He'll get you a Cartier doll, no sweat. He can pass through the pornocracies—Patphong, Nana, Cowboy, Suriwong—like a ghost through walls."

"As you say," said the stranger, inhaling languorously on his cigarette. "*amazing*." He looked askance, ready to snare my reaction, adding, with studied disinterest, "What's the secret?" Against my will, ravished, a sad, sad slave to lust, I smiled conspiratorially. Harry saw (he knows my little ways) and drummed his fingers on the table.

"Secret is seven hundred thousand baht. Half of it up front. Secret is no one knows outside this room. Secret is letting us do our job with no questions asked. Then you get your *dtook-gah-dtah* and everyone's happy."

Milord swept back his golden hair. "Seven hundred thousand baht," he reflected. "I'll have to think it over." Harry's lips didn't move, but his face screamed, *Time waster!* The stranger pushed aside his glass and rose. "I've some things to do. Nice bar you have here." Harry picked up a copy of the *Bangkok Post* and pretended to scan it.

"You know where you can find me."

"And good to meet you, Mosquito." His right hand was gloved, concealing, perhaps, a prosthesis. Teasingly he squeezed my arm. It was an intimation of fellowship, of understanding. "Mosquito. Why do they call you that?"

"Just a name," I said, "a silly name."

And then he was gone.

When he had touched me, I had felt a pinprick in my arm, like a discharge of static. I lifted my shirtsleeve and recognized the telltale mark—like that of an insect bite—left by an epidermic tracer.

"What's wrong?" said Harry.

"Mosquito bite. Mosquito." I said, scratching. Harry burrowed into his paper. A nasty, unidentified virus simply called klong fever was ravaging Bangkok. It was said to be transmitted by insect bites, only affect males, and leave its victims impotent. But since no *farang* had been known to succumb, Harry had shown little concern.

The tracer could be removed with tweezers, but its itch, counterpointing that which I felt in my loins, made me reluctant to destroy it. I wanted him, and he, it seemed, wanted me. Did I ask myself why? No, my darlings. Mosquito has an extravagant heart. Closing my eyes, I beheld the blazing lines of Mr. James dancing across my retina, like the afterimage of a fierce summer's day your aching eyes have forestalled on. I saw him, incandescent among dark London streets, a lean man dressed in light, window-shopping for automata. His cold eyes appraise their wonderful, jeweled forms as he walks down Piccadilly and into Bond Street. And there, in a Cartier showroom, he sees me and falls hopelessly in love.

I heard Harry throw aside his paper, the scrape of his chair. "Make hoochie-coochie with a customer again," he said, "and I'll break your arms."

That's Harry.

That evening, back at my condo, I prepared for work. Seiko mechanettes (they of the regenerative maidenhead) had recently been decanted for bars in the Silom Road, and Harry wanted a report. On the heat-ruptured surface of my dresser I placed my creams, paints, and powders, my unguents and emollients, then, laying out my she-clothes, I sloughed off my daytime skin and became The Doll. My alias winked at me from the other side of the mirror. She has a delicate, childlike

face, my sister with vestiges of puppy fat about the cheeks. Bobbed hair gives her an appearance of delinquency, as do the eyes, crescent and puckish, burning like black suns. The lips are set in a pout, communicating both desire and disdain. And the complexion—the faultless, lacquered flesh of the gynoid—proclaims her synthetic. Her sartorial ensemble? A leopard-print body stocking and six-inch stilettos. The genitals, of course (always a problem), have to be secured with Scotch tape giving the appearance of a distended mons veneris. I smiled, checking my fangs. Perfect.

I lay on the bed and browsed through some physical culture magazines while the radio murmured of love lost and found to the indifferent *whup, whup, whup* of the fan. The microscopic transmitter throbbed caterwauling across the city to Milord. I pressed it to my lips. Instantly the imperative of that evening's work was subverted by a premonition that he would call, not tomorrow, not next week, but tonight. And I preened myself, again and again, jittery as a girl preparing for her first date. My deceptions were unrivaled, if incomplete. Harry, who had paid for my implants and other, more radical surgery, had insisted I retain a flow of testosterone in my veins. Only a man could imitate a doll. Women were too real. For dolls are not women, they are man's dream of women. Made in man's image, they are an extension of his sex, female impersonators built to confirm his prejudices. Sexual illusionists. I, too, was practiced in sexual sleight of hand, my womanhood as unreal and as pathologicelly exquisite as a doll's. So exquisite, it was almost grotesque.

The intercom buzzed. "Someone to see you, Madame," said Zip. "A Mr—" But Zip was given no time to complete the formalities. Instead of "James" (my heart lurched, telling me it was so) came the announcement of electromagnetic crackle and bar-brawl sound effects. I rolled off the bed, nauseous with anticipation. The hallway stank of roasted Bakelite. Mr. James had been unnecessarily heavy-handed, Zip was a valet, not a security guard (though his cosmetic musculature and barrel chest often led people to conclude otherwise). I breathed deeply, trying to remember my lines, quell my stage fright, ignore the anxious clickety-clack of my high heels on the teakwood parquetry. I made my entrance.

Milord stood over a broken coffee table, silk jacket ripped, Panama askew, his leather-gloved prosthesis smoking, and Zip, horizontal amid the debris, scorch marks either side of his shaven head, looked up at him dead-eyed with a demeanor as herd end vulnerable as the Mapplethorpe portraits that lined my walls. Hands on hips, lips quivering like a spoilt, refractory child's, I cued in, "You want kill me, too?" His eyes grazed my body like the feather-light tips of rapiers. It was a good body, I reassured myself, an expensive body, a body I always regretted having to camouflage by day. Exaggeratedly feminine, it was grafted onto a small-boned, somewhat adolescent infrastructure, like a piquant allegory of innocence burdened by desire.

"You very naughty, Mr. James. Just look at poor Zipper!"

"Mosquito?" I curtsied in acknowledgment. "Good God, I've seen lots of he-shes in Bangkok and some of *them* were fantastic, but you... Seems you might be worth all this trouble."

"I think Trouble your middle name, Mr. James."

"Sorry about Man Friday."

"Not organic. Not *modern* doll. Backed up. Running in an hour." He straightened his hat and fumbled in his pockets. "Chocolates? Flowers?" I asked, mock expectant.

"Seem to have lost my cigarettes." I bent down, retrieving a silver cigarette case lying beneath a scree of broken glass. I helped myself.

"Light me." Like a tiny, nervous dragon, a Dupont flickered and withdrew. "Nice lighter."

"Nice workmanship," he said, screwing a monocle into his eye, awarding me a detailed examination. "Unreal."

"Unreal as a doll. Unreal as love..."

"And cool. I'm impressed."

"Tracer Sfung me in Gung-Ho. I know you come. I not stupid."

"I don't believe you are, dear boy, or you would never have allowed me to find you."

"Curiosity, Mr. James."

"Desperation, I'd guess. Oh, I know all about you, Mosquito..." He turned his back to me, stepping over Zipper and walking to the window to stare down at the night-transfigured city thirty floors below. "Aren't you tired of working for that American pimp? Is he the one who tells you to speek and act like some second-rate Suzie Wong?"

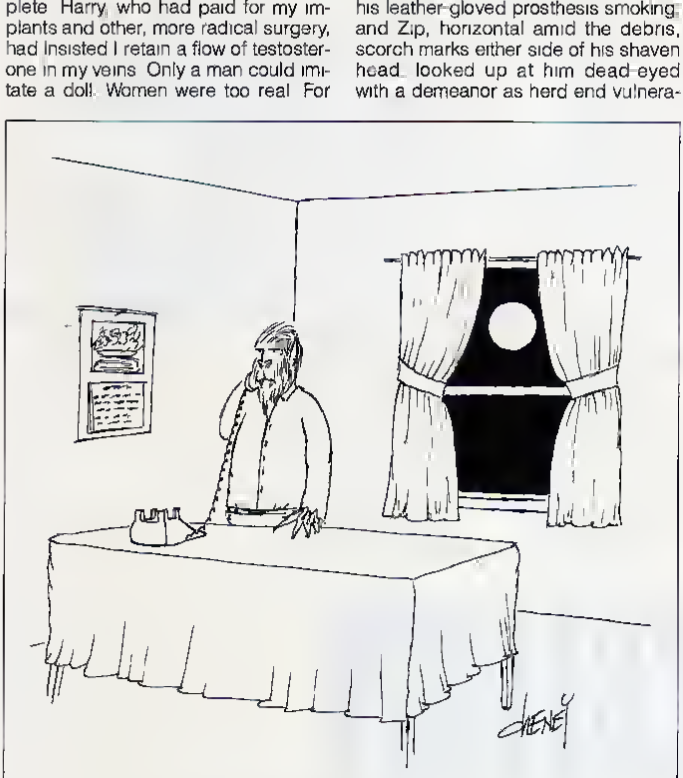
I let fall a tear, not altogether crocodile, but prompted more by the exigencies of coquetry than by genuine sorrow or regret. It was wasted. He did not deign to look me in the face.

"Harry likes me to telk thet way," I said, throwing off my Third World guise. "Says it reassures the clients. What *exactly* do you know about me, James?"

"Everything, little Mosquito..." A blue-gray nimbus of spent nicotine was forming above his head, like the signature of a prosecuting angel. "How would you describe your childhood?"

"Idyllic." He laughed.

"Spoilt little rich boy. Your father a big



"Thank you for calling the lycanthrope hot line
All of our operators are busy right now, so if you will please hold..."

name in sericulture. And your youth?"

"Gilded."

"But oh so soon tarnished! You studied at Cambridge, yes?"

"I was happy there ..."

"I'm an Oxford man myself. Anyway, you took a postgrad in comparative literature. Your thesis: The Second Decadence. Literature of the 1990s.' Then you got into that scrape with Lord Dagenham's son. And he only fourteen. How *wicked*. Your father ordered you back to Thailand. Cut you off without a satang. Poor Mosquito, it's been downhill ever since ..."

"How do you know all this? And why tell me?'

"Because I'm feeling philanthropic, dear boy. How much money do you get from the American?"

"Not enough to leave him. This apartment's his. He keeps nearly all the money from our jobs. Even Zipper's on loan. My father's made it impossible for me to get a decent job ..."

"I wouldn't have you wasted on decency, Mosquito. The next job it'll be just you and me. And this time you'll take enough of the percentage to enable you to shake Harry off for good."

"So much?"

"I need my doll, Mosquito. My Cartier doll. And I need her tonight. Passport, visa—I have my contacts for that. But I must have her before morning."

"Do you need your doll so bad James?'

"Name your price." He about-faced. I held his reptilian stare. There had been other Englishmen. Some quite pretty. None had offered me escape. But I had known that one would come who would be special, who I would recognize by his incomparable beauty, who would, at last, carry me off to his castle in the sky. My prince.

"I don't want money, James," I said tremulously, "I want to go back to the land of ice and snow. Take me with you, James. Take me to England." In petulance he swung open the plate-glass doors and stepped onto the veranda. The tropical night crashed into the room. I followed him outside.

"Dear boy, what sort of foolishness is this?"

"The first time I saw you ." I began, but he cut me short.

"Please—let's not make this complicated, Mosquito, you don't want to go to Europe.' He waved his hand over the roofs of Bangkok. "Look out there. You think Europe can compete with this?"

Below us the city glistened like a well-oiled body, rippling under the stars. It offered forbidden technologies, flaunted stolen ideas. It mocked the impotent West. Europe had sickened, its economy in misrule. An empire of style, it had surrendered manufacturing to 'the Pacific Rim and the Americas, investing instead in the refinement of those luxury,

CONTINUED ON PAGE 93

"The abductions are real The fear is real But the little gray men may actually be hypnotically implanted memory screens"

ANTI MATTER

UFO UPDATE

Listen carefully to the stories of those who insist they have been shanghaied by otherworldly visitors, says Martin Cannon Then take a close look at the horror stories told by those who claim to be victims of the government's clandestine mind control programs What you will find, he says, are some very surprising similarities

Cannon, a commercial illustrator working in Los Angeles, spells out his findings in a provocative 53 page manuscript called "The Controllers," which has been circulated informally to members of the UFO community Cannon is convinced that the CIA and other government agencies have made "striking advances" in thought manipulation, despite their denials to Congress, and that clandestine research on this topic did not end, as claimed, in 1963 He then proposes, as a "working hypothesis," that 'the UFO abduction phenomenon *might* be a continuation of clandestine mind control operations "

The technology to pull this off, says Cannon, seems to exist For example, the implants that UFOlogists such as Budd Hopkins say are visible in the brain scans of some abductees strongly resemble devices our own scientists have worked on since the early Sixties For years in fact, neuroscientists have been able to induce emotions and behavior in animals and people using miniaturized electrodes implanted in the brain Such devices have reportedly caused floating sensations and sexual arousal as well as an altered sense of time

So, Cannon declares, the abductions are real The fear is also real But the little gray men are not

'They are constructs," he says, "Halloween masks meant to disguise the real faces of the controllers By hypnotically implanting a screen memory involving aliens and spaceships to cover their own tracks the controllers take care of the nagging disposal problem—what to do with all the victims of electroshock, hypnosis, and drug experimentation " The victims are just talking about space brothers, he says, "rather than Big Brother

Those not wed to an out-of-this-world explanation for UFO abductions seem willing to entertain Cannon's hypothesis "What takes place during the abduction scenario is more consistent with what humans do to other humans," says New York criminal defense attorney Peter Gersten, "than what aliens might do to us "

Most CIA experts, however, dismiss the notion out of hand William Lear, a University of Georgia historian specializing in CIA matters, says, "People who see the CIA in everything seem to have the same kind of mind-set as those who are prone to believe in the presence of aliens They give the CIA credit for far too much It is *not* an omnipresent organization ' Meanwhile, John Marks, the author of *The Search for the Manchurian Candidate*, a book about the CIA's secret mind control program, says he knows nothing on the subject of UFO abductions and has no interest in it And the CIA? Spokesperson Mark Mansfield's reply was unequivocal· "I've never heard anything so ridiculous in my life "—*PATRICK HUYGHE*

MAGNETIC GHOSTS

When a loved one dies, the grieving survivors often report visions of the deceased. And now neuroscientist Michael Persinger has linked these visions to changes in the earth's magnetic field.

To reach this conclusion, Persinger, who works at Laurentian University of Sudbury, Ontario, gathered 203 reports spanning a 37-year period and compared them with the amount of geomagnetic activity that occurred before, on, and after the day of the apparition. His finding: These "bereavement hallucinations" usually took place when magnetic activity was relatively high.

Persinger suspects that the increase in geomagnetic activity electrically stimulates the temporal lobes of the brain. This, in turn, causes a drop in the level of the biochemical melatonin, found in the pineal gland. The drop in melatonin induces small seizures that transform memory fragments into visual images.

To validate his theory, Persinger has been applying magnetic field pulses across the temporal lobes of subjects while they wear opaque lenses and sit in a quiet room. 'They report their subjective experiences but don't know whether the pulse is on or off,' says Persinger. "People report a lot of visual imagery,' he says, 'and they think that there is a presence, that some entity is in there with them when the pulse is on."

—Paul McCarthy

"You know what scares me? When you have to be nice to some paranoid schizophrenic just because she lives in your body."

—Steven Wright

"The breaking of a wave cannot explain the whole sea."

—Vladimir Nabokov

SAUCER FLICKS

If alien craft visit Earth regularly, why do UFO buffs have such a hard time faking good photographs of them? Gary Levine, who has researched UFO sightings for more than 20 years, thinks he has discovered at least one cause: The photographers don't have ESP.

Levine's proof? The UFO movies taken by Patricia Baldwin, a nurse and mother from rural upstate New York.

Baldwin, who doesn't consider herself clairvoyant, had her first UFO experience two years ago, when she spied an unusual light from her bedroom window. "It changed from red to white to green,' she says. Hearing that Levine, a professor at nearby Columbia-Greene Community College, investigated UFOs in his spare time, Baldwin approached him with her tales.

"I questioned her and concluded she possessed some psychic ability," Levine recalls. Long interested in paranormal photographs supposedly taken by clairvoyants in the nineteenth century, Levine suspected Baldwin's psychic abilities might somehow help her capture UFOs on film. So Levine loaned Baldwin a camera. Eventually she photographed two triangles—one above the other—along with the broken light streaks associated with UFOs.

Levine quickly gave Baldwin a super-8 movie camera, and she soon produced eight reels of UFO footage—including images of blinking lights and two very large needle-shaped objects.

But what *exactly* do the films show? So far, experts asked to examine them aren't sure. Richard Powell, professor of criminal justice at Columbia-Greene, studied the original movie, frame by frame, with an electron microscope. "The document is authentic. If had not been cut or altered in any way," he says. "But I can't tell if these are pinpoints of light in front of the camera or huge objects at a distance—there's no way to tell."

As for Baldwin, she now insists she has observed several thousand UFOs—including a disc that appeared to have brightly lit windows. "I feel I shouldn't be afraid,' Baldwin says. "But I can't help it. I'm definitely not driving by myself at night anymore."

—Sherry Baker

"One always has to spoil a picture a little bit, in order to finish it."

—Eugène Delacroix

Parapsychology is just like mainstream science in at least one regard Men publish far more frequently than women To reach this conclusion Nancy L Zingrone, a Duke University graduate student in history, checked two journals—*Parapsychology* and the *Journal of the American Society for Psychical Research* Sampling two decades, including the years 1937 to 1946 and 1977 to 1986, Zingrone found that though women make up slightly more than half the general population, they have never made up more than a quarter of the roster of publishing parapsychologists. In other disciplines, women comprise closer to one third of the authors

More distressing is the fact that in parapsychology, at least, women continue to lose ground to men Over the past 40 years, the number of women listed as authors declined by 13 percent And if you compare the most frequent women contributors for the two periods, it s clear that 40 years ago their output was greater than today

This is Zingrone's first analysis of the information, and she doesn t delve into the ramifications Why, for instance, with presumably greater opportunities in modern times, are women losing ground? With further investigation Zingrone hopes to shed some light on why gender differences persist in parapsychology and science in general

—Steve Fishman

"My breasts aren't actresses "

—Liv Ullman

"Anatomy is destiny "

—Sigmund Freud

"Ex ovo omnia Everything from an egg "

—William Harvey

ELECTRONIC OUIJA BOARD

Thanks to an attorney from Huntington Beach, California, we may soon be communing with spirits by computer The lawyer, E. D. O'Brian, has patented the 'Message Type Recording Psychograph, ' a sort of electronic Ouija board

According to the patent, O Brian's invention resembles the classic Ouija board It is rectangular and has letters, numbers, and punctu ation marks printed in curved rows on its upper surface It also uses a free moving indicator, or planchette, which is pushed across the surface of the board until—guided by some subconscious or super natural force—it stops above a series of characters and spells out a message

But there the similarity ends O Brian's planchette, which is magnetic, triggers a different metal switch every time it stops over a different symbol of the board "When activated, the switch es send electrical impulses through a cable to a key board encoder that translates the signal into a form that can be read by a computer or electronic typewriter,' says O Brian ' Essentially, when a charac ter is selected it is instantly recorded Being able to automatically print the characters will increase the speed messages can be received and make psychographic devices easier to use," he explains 'The Psychograph will also leave the user's concentration unbroken since it will not be necessary to stop and write down each and every letter after it has been chosen '

While never using the device as a psychic tool himself, O Brian takes his invention seriously These things are not toys in any way, shape, or form The messages may come only from the subconscious, but the inventive ability of this part of the mind is vast "

—Edward Duensing

"An idea had just come into her mind, but had not yet reached her lips "

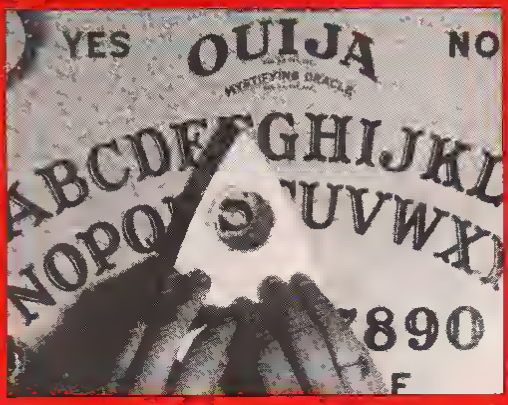
—Lawrence Durrell

'People think of the inventor as a screwball, but no one ever asks the inventor what he thinks of other people "

—Charles F Kettering

"People will accept your idea much more readily if you tell them Benjamin Franklin said it first '

—David H Comins



FUTURE DREAMS

The late Berkeley psychologist Helen Wambach believed that under hypnosis the dreaming mind could accurately describe previous incarnations. During the late Seventies and early Eighties she guided more than 10,000 men and women through such past-life regressions. But before her death in 1985, Wambach embarked on an even more extraordinary project to *progress* a group of volunteers into the future for a look at the world to come.

One of these volunteers, Chet B. Snow, is now continuing Wambach's work and has already collected some 500 trance-induced accounts of life over the next five centuries. The basic scenario for the near future, explains Snow, includes such totally devastating natural disasters as massive climate shifts and worldwide earthquakes.

In the wake of these cataclysmic events, respondents predicted four basic living situations: in space, aboard rudimentary space stations; in New Age communes, eating foods like tofu and green beans; in wrecked landscapes, foraging for weapons and food; or in domed high-tech cities protected from the poisonous atmosphere outside.

After the year 2250, a brighter vision kicks in. Respondents predicted life spans of 150 years or more and described future lives spent in colonies on Mars and in the universe beyond.

Explanations other than clairvoyant insight may account for the pessimistic near-term forecasts of so many of Snow's subjects. "People often see the future in the bleakest possible terms as a defense mechanism to cope with disappointment," says psychotherapist Rinaldo Petronio. "It doesn't mean that it will actually happen."

But Snow isn't so sure. His research has convinced him that his subjects' mass dreams represent at least partial glimpses of the future. "If these are pure fantasies," he asks, "why do they fall into such cohesive groups? Why isn't there more variety? Why do so many people see the same thing?"

—Jeff Goldberg

There will be no nuclear war. There's too much real estate involved.

—Frank Zappa

INTIMATE ABDUCTION

Mix a tall, dark, handsome alien with a sensitive, virginal earthling pianist, add forbidden love, nasal probes, and interspecies breeding, and what do you get? *Intimate Abduction*, Ann Carol Ulrich's new UFO romance novel, published by Earth Star Publications in Paonia, Colorado.

The idea for the novel came to Ulrich after she had the disconcerting experience of waking to the sound of people speaking in a foreign tongue. "It just sort of rattled me," she says. "It wasn't that big a leap then to have her heroine awaken, only to find herself speaking a gibbensh that no one understands. She lands in a mental institution and soon begins encountering other speakers of the same language. As it turns out, she isn't crazy, she has just met up with some E.T.'s."

Working by day as associate director of the UFO Contact Center International in Delta, Colorado, Ulrich helps people deal with UFO sightings in their everyday lives. Her organization, she says, "fills the void left by UFO groups that focus on the sightings, but don't always pay that much attention to the emotions of the people themselves."

Delving into her everyday work, Ulrich wrote her story with the human experience in mind. The story line, she says, will reach those who would not normally read about UFOs.

—Paul McCarthy

FAR PLANET

CONTINUED FROM PAGE 38

of the effort. At present there are more than 380 station assembly elements scheduled for delivery to low Earth orbit on about 30 shuttle flights over a period of four and a half years, scheduled to begin in the mid-Nineties. Such an orbiting platform would be just one part of a moon–Mars program. A lunar base itself would need far more launch capacity than the station. Besides the living modules, rockets would also have to hoist heavier power plants, surface rovers, and more complex communications gear.

Only the Energia has the capacity to boost such tonnage to space. "The Soviets have built a heavy cargo vehicle," says Art Dula, president of Space Commerce Corporation, which is marketing Soviet launch services in the United States. "We need a dump truck and all we have is the family Rolls!"

Mere technical grounds rarely win this sort of argument, however, so don't expect the United States to depend on the Energia for its heavy-lift needs. It would be more likely to revive work on the Advanced Launch System (ALS). ALS started in 1987 as a program to revolutionize American rocket technology and lower the cost to orbit by a factor of ten. Lately the effort has had its funding cut for lack of a clearly defined mission. Moon–Mars just might turn out to be that mission.

Ultimately nuclear fission or something even more advanced—such as fusion—will probably be the only way to bring down the cost and one way travel time. Nuclear propulsion might cut the trip to 100 days from the 550 days a chemical rocket would take. Although Westinghouse started working with Los Alamos laboratories on this approach in the late Sixties, according to an industry insider who requested anonymity, the technology is still not operational. To get the voyage down to 50 days would take even more advanced motors—such as those using helium 3 for nuclear fusion. Unfortunately, after millions of dollars of government-funded research, scientists are still unable to control fusion reactions.

NASA's Lunar Energy Enterprise Case Study Task Force recently issued a report on helium 3, which is rare on Earth but plentiful on the moon. The group suggested that in the future the element could fuel fusion reactors to power spacecraft.

FIX IT OR DIE

'Mass approaching twelve o'clock, diameter ten centimeters, speed six kilometers per second, impact imminent!' The computerized voice echoes through the spacecraft, the impact shakes the structure. Everything necessary to repair the ship must be either available onboard or jury-rigged by an ingenious crew. There is no alternative. The voyagers are 3 million miles from Earth, and Mars is another 45 million miles ahead.

"You can't have a Cape Kennedy in orbit," declares Mark Craig, NASA's special assistant for exploration and point man for the moon–Mars initiative. "So how do you build a spacecraft that will exist in space for years with little or no human intervention? You need self-diagnostic ability and repairability."

Current manned space vehicles have an average MTBF (mean time between failures) of 10,000 hours. In other words, more than half of them may fail within a year. Even on the Soviet *Mir* space station, where replacement parts can arrive within 30 days, the crew spends large amounts of time repairing equipment, observes Nicholas L. Johnson, advisory scientist at Teledyne Brown Engineering and author of the annual compendium *The Soviet Year in Space*. "The Soviets have had significant problems, especially after the first two to three years, in maintaining the *Mir*," he says. "They've done a great job, but it's been at the cost of a

SHOULD WE JOIN WITH THE SOVIETS IN A JOINT MISSION TO MARS?

PICK UP A TELEPHONE AND VOTE IN OMNI'S SURVEY.
SHOULD WE HEAD FOR MARS WITH THE SOVIETS AS OUR COSMIC COMPANIONS? OR POSSIBLY THE JAPANESE?
PERHAPS YOU THINK WE SHOULDN'T GO AT ALL, AND SAVE THE U.S. TAXPAYERS OVER $400 BILLION DOLLARS IN COSTS. LET YOUR VOICE BE HEARD.
THE RESULTS OF OUR POLL OF OMNI READERS WILL BE SENT DIRECTLY TO **VICE PRESIDENT DAN QUAYLE**, CHAIRMAN OF THE NATIONAL SPACE COUNCIL, AND WILL APPEAR IN AN UPCOMING ISSUE OF OMNI MAGAZINE.

VOTE BY TELEPHONE IN THE OMNI MARS MISSION SURVEY

900-386-OMNI

6 6 6 4

75¢ EACH ADDITIONAL MINUTE

The Artist

lot of lost cosmonaut time for conducting experiments. That's in low Earth orbit. For any deep-space mission, repairability is essential. "If you can't fix something," says Johnson, "you'd better have another one along with you."

R2-D2, CALL YOUR OFFICE

The robotic servicing unit's TV optical system transmits the faint glow of the ruptured nuclear power plant to the operator bent over her screen three kilometers away in the lunar module. *Damn,* she thinks, *yesterday's meteor impact breached the first two layers of the triple shielding; any more damage would have caused a meltdown.*

No human could go near a reactor in this condition and survive. Closeup repairs of the shielding are no problem for her teleoperated robot, however. Its "eyes" let her zoom in on the damage; the "smart" gloves she wears let her move the robot's "hands" to feel the reactor wall. Thanks to the dexterity with which she can manipulate her distant partner, repairs are finished in a single eight-hour shift.

Making repairs outside a ship in space is a risky business for humans. When possible, spacefarers will employ futuristic teleoperated or fully independent robots equipped with sensors able to distinguish texture, "hands" with "fingers" that can feel delicate gradations in pressure, plus enough artificial intelligence to learn from experience and program themselves. "This is an area where Japan can contribute a lot," says Hajime Furuta, MITI representative in New York, referring to Japan's demonstrated virtuosity in robotics.

Canada, the nation that gave the shuttle its manipulator arm, is also a major player in robotics and automation. At present Canada-based Spar Aerospace is developing the Mobile Servicing System that astronauts will use to build and maintain the space station. Furthermore, robotics will play a major role in mining the lunar regolith for construction materials and rocket fuel, and in covering habitation modules with soil to protect against radiation. "We have an active mining community," says Dr. Frank Vigneron, who chairs the Canadian Space Agency's Working Group on Moon–Mars Exploration, "so there's possibly a role for us in the production of robotic vehicles to do similar work on the moon."

Mining, construction, and other robotic activities, however, will consume more energy than existing power-generation techniques can supply. Space Station *Freedom*'s big solar arrays, for example, are expected to provide a total of about 75 kilowatts—barely enough to keep the station running and do any work onboard.

A moon–Mars mission will require far more power than the station. "I think nuclear power will be needed," says Huberman. "The United States is working on the SP-100 nuclear power source, and the Soviets run their Rorsat with nuclear reactors. So to the extent that nuclear is required, it will be an American–Soviet show."

A LITTLE SHORTER IN THE PANTS, PLEASE

"Two dozen suits in the locker and not a damn one working in my size!" fumes the geologist intent on getting out onto the Martian surface while the pink Martian sky is still bright with sunlight. Within limits, the suits can be resized to fit different human frames, but right now all the ones suitable to her height and build are out of commission. Whether in the vacuum of space, the airless surface of the moon, or the tenuous atmosphere of Mars, the fragile human body must be sheathed and supported by the elaborate protection and life-support systems of a space suit.

The International Latex Corporation space suit used on the shuttle is a remarkable piece of gear—but is too delicate for regular wear in space or on the dirty surfaces of the moon or Mars. The garment needs hundreds of hours of repair and reconditioning after every spacewalk and takes days to resize to a differently proportioned person. It also takes hours to get into one and prepare to leave the ship.

To avoid developing the bends, even before dressing, the intrepid traveler must spend from 40 minutes to four hours breathing oxygen before setting out on the EVA. The reason: Shuttle space suits operate at a very low 4.3 pounds per square inch (psi).

First an astronaut dons a liquid cooling and ventilation garment, designed to keep internal temperature bearable, laced with a network of flexible tubing. At this time the urine collection device is also put on. Next come the lower torso pants, boots, hip, knee, and ankle joints. Then follows the upper torso, including arms, the umbilical and electrical harness containing communications, power and oxygen lines, connections to the portable life-support systems—and the Hamilton Standard life-support backpack. Finally the spacefarer slips into gloves, helmet, and visors.

Unfortunately, shuttle suits are too heavy for use in the lunar or Martian gravity fields. Built for zero gravity, one weighs more than 200 pounds on Earth. "The weight has to come down," says Lee Weaver, a California consulting pilot engineer who has worked in every EVA program (and worn these suits) since Gemini. "The suit has to have better lower body mobility and it has to be able to stand up to the lunar or Martian environment.

"EVA is going to be a make-or-break factor in assembly and surface operations," he continues. "Unless and until we have nuclear power to support planetary surface operations, human muscle is going to be one of the primary ways to make things happen." That will require major advances in space suit design.

NASA is now working on better garments. At Johnson Space Center a team is developing an 8.6 psi outfit that would eliminate the need to breathe oxygen for hours before an EVA. Unfortunately, the suit has to be sturdier to handle the increased pressure. "That, in turn, makes glove dexterity a problem," says Weaver. "And you can't use pure oxygen at that pressure because it's too flammable, so you have to use both nitrogen and oxygen, which requires the addition of pumps, regulators, and gas sensors. That adds to the weight—and we need lighter, not heavier, suits to operate in the gravity fields of the moon or Mars."

A completely hard suit, the AX5, is in the works at NASA's Ames Research Center. Its all-aluminum shell offers a vast safety improvement over soft suits, according to Weaver. It does have a challenge to meet, however. In a gravity environment the AX5 will have to be modified to stand up by itself when inflated (as a soft suit will).

STRING THING

"Ahhh, that's better! Gravity at last. Ten years in the space biz and I still get spacesick when we hit orbit!" The computer systems troubleshooter relaxes gratefully onto her couch and lets her stomach settle down as the habitat module starts to spin at the end of its kilometer-long Kevlar tether and the resulting centrifugal force creates a modest level of gravity. Tomorrow an elevator will crawl up that cable, taking her to weightlessness again at the spin center of gravity, where she will attempt to coax a balky computer system into functioning properly. For now, at least, she'll be able to relax in comfort—and keep her dinner down.

The absence of gravity does very nasty things to the human body. After even a few days, astronauts lose bone calcium, cardiovascular conditioning, and electrolytes. The most commonly used preventive measure discovered to date: two to four hours of strenuous exercise every day. On a three-year mission such a workout schedule might prove both hard to maintain and inadequate to the cumulative health impact of zero g. Some form of artificial gravity, therefore, may play an essential role in the Mars voyage.

One way to create gravity is through the centrifugal force generated by spinning two objects (such as a spacecraft and a counterweight) connected by a long "string."

Such tethers will be long cables of woven Kevlar deployed like huge fishing lines from space platforms. Research into this technology has progressed quietly in recent years—to the point where the shuttle is slated to test one in September 1991. Plans call for astronauts to uncoil a 20-kilometer-long tether with an Italian satellite at its end. How much time might it take to scale up from this demonstration level to an artificial gravity system for a functioning spacecraft?

"Not too long," predicts Al Schallenmuller from Martin Marietta, which has been working with NASA for years on tethers. "The main areas that we need to master are some of the dynamics in the cable and some of the electrostatic charges generated in it when it's flying in space."

Another way to simulate gravity: Create centrifugal force by spinning the spacecraft alone. "But if you do that," says Larry Bell, director of the Sasakawa International Center for Space Architecture at the University of Houston, "you also create problems with orienting communications antennas, radiators, and solar power arrays." Beyond these difficulties, the craft must rotate in a wide enough arc to avoid causing an inner ear disorder called the Coriolis effect, which results in a loss of balance. "With a radius of fifty-six feet, we can reach six revolutions per minute, which provides two thirds the earth's gravity," says Schallenmuller. "But higher rotation rates," he adds, "would require a longer radius and create a need to shore up the structure to brace it against propulsion stresses."

GLOW FOR THE GOLD

"How many more flights are they going to allow you?"

"Only one. I'm already pushing the radiation dosage limit."

"That's a heartbreaker. Who's going to finish out your experimental series?"

"One of my graduate students. I think. He's smart enough—if he decides he wants to risk the possible chromosome damage. I think he wants kids eventually. He just doesn't want them to have two heads!"

The two scientists laugh hollowly, contemplating the difficulties of conducting research in space. After all, some necessary experiments take longer than human tissue can withstand the onslaught of solar and cosmic radiation.

Experts in space medicine now place such risks at the top of the health hazards list. "We're using standards that are very, very speculative," warns Bell. "We're already allowing dosages for astronauts that are ten times what we allow for radiation workers on

Earth It's not simply a matter of adding shielding, either That increases the ship's weight, and far worse, spacecraft walls can become ionized, making the radiation problem worse This issue is a potential showstopper—and it's the one we know the least about!

NASA is now talking to the Soviets about their space medicine experiences The agency has even discussed joint research efforts—such as flying U.S. astronauts and using American medical protocols aboard *Mir* Two important areas in which such a program would help an assessment of the need for artificial gravity and research on radiation effects

FARMER IN A DRUM

"Well, let's see, you raise the fish in the rice paddy tanks, and you filter the water by running it through the soil in your vegetable garden—you better have enough termites in there to clean up the dirt, by the way—and oh, yes, I'd stock some chickens that still know how to sit their eggs—they bred it out of the stock twenty years ago, you know—and The space ecologist talks on, while his listener strives to grasp the complexity and expense of equipping a completely self-contained spaceship capable of taking his Martian Tours customers ("For the Traveler Who's Been EVERYwhere!") safely and comfortably to the red planet

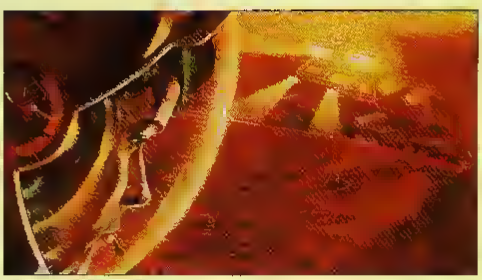
To stay alive in orbit and on the lunar and Martian surfaces, people will need closed life-support systems that can recycle air and water, grow food, and stay habitable for years or even decades at a time There is nothing of the sort available now Neither the shuttle nor *Mir* has closed life support both depend on resupply from Earth The shuttle lands between missions Approximately every 60 days the Soviets launch a Progress to *Mir* carrying two and a half metric tons of various supplies—such as propellants, water, air, food, film, and space suit spare parts "To support a two-man crew for a year takes five to six such flights," says Johnson "That's about fifteen tons of material every year for just two people" Although Space Station *Freedom* originally had a closed oxygen system, last year that idea was dropped in favor of the *Mir* approach, to save money No such option will be available for a Mars journey there aren't any supply depots along the way It's recycle or die

Let's assume engineers master all these problems of equipment and hardware The hardest part still remains keeping fragile, ornery humans physically and psychologically healthy for months and years cooped up in spacecraft or surface structures the size of big-ish school buses, in a hostile environment away from family, friends, fresh air, blue skies, and the earth's gravity field "The human being is the weak link in the chain, and it's a very weak link," says Susanne Churchill, associate director of the Institute for Circadian Physiology in Boston. "We typically put enormous effort and money into building spacecraft but nowhere near the necessary level of work into the matter of the crew. Unless we focus on the human aspects, we may engineer ourselves a perfectly elegant ship to launch to Mars—and find we can't in good conscience put people in it."

TIGHT QUARTERS

"I can't stand it any longer!! If you whistle that tune one more time, I'll kill you!" The technician clings to a hand brace on the wall of the spacecraft's galley, menacing his shipmates with a knife, his eyes wild The others hover at a cautious distance while the ship's psychologist tries to calm the distraught man down It's his third crack-up this week *The trip's too long; we're too far away from home,* she worries Even the best prelaunch psychological profiles can't predict what will drive people crazy several million miles from Earth

MISSION POSSIBLE: HOW TO GET TO MARS



As the argument grows over the best way to go to Mars, the White House National Space Council refuses to be rushed into a premature decision about mission architecture It has already stated that it will take several years to define two or maybe even more mission plans In the meantime there are already three major proposals

- NASA's "90-Day Study" done in 1989 at the request of the National Space Council Its chief characteristics are caution and the minimization of risk Plans call for the development of heavy-lift vehicles to truck equipment and humans to low Earth orbit for assembly operations at Space Station *Freedom* Unmanned robotic precursor missions to case the lunar and Martian surfaces in detail would also be scheduled (Apollo mapped only part of an equatorial strip between roughly 40° north and south on the moon, and we know even less about the closeup details of the Martian surface) The study estimates that it will take a decade or more to research ways to counteract the effects of low or zero gravity on the human organism During this time a permanent base established on the moon will serve as a proving ground for the move to Mars Price tag: a cool $400 billion over 30 years by NASA's preliminary estimate The final cost is likely to be a lot higher
- Lawrence Livermore National Laboratory's "Great Exploration" proposal concentrates on getting to Mars by the end of the century, because "there has never been a successful twenty-five- to thirty-year federal technology program" Its salient characteristic is a reliance on inflatables instead of heavy, rigid structures thereby drastically lowering projected lift requirements Price tag: about $10 billion but at the cost of a much higher level of risk This gives the proposal a certain air of dash and adventure Everybody seems to admit that it deserves at least further study
- "Bridge Between Worlds," laid out in the 1986 report of the President's National Commission on Space *Pioneering the Space Frontier* (the "Paine Commission Report") The grandest vision of all calls for a full-fledged interplanetary infrastructure linking Earth, the moon, and Mars When completed it would include spaceports orbiting each body and permanent bases on the lunar and Martian surfaces—all tied together by a fully equipped cycling spaceship permanently orbiting both the earth and Mars No price tag estimated but sure to be a humdinger

Spaceflight is tough duty even close to home in low Earth orbit. When this reporter first met Dr. Oleg Atkov, the Soviet cardiologist who spent nearly eight months in orbit on *Salyut 7*, he mistakenly complimented him on enduring 236 days there. "Two hundred thirty-seven," he ruefully corrected, "because every day you count!" With cosmonauts staying in orbit for as much as a year at a time, the Soviets have accumulated more experience than any other nation in the psychological problems of spaceflight. The techniques they've developed attest to the complexity of the problem. Every mission has a full-time ground-based psychological support group. Cameras onboard the space station allow psychologists on the ground to monitor crew interactions, watching for indications of tension. Cosmonauts' voices are monitored for signs of stress. Regular radio and TV contacts with families, friends, and prominent Soviet personalities boost crew morale. Mail, pictures, and tapes of Earth sounds go up on every Progress resupply module. Thus far, it's worked. Nobody has murdered anybody else in space. But that's only in low Earth orbit. Psychologists will need a whole new set of techniques to deal with people who are many millions of miles away for years at a time. Perhaps by the time people venture to Mars, advances in computer and other technologies will let them talk to Hal-like psychologists based in the ship's computers, gaze at holograms of their loved ones, and their favorite vistas, or dream in some form of suspended animation to pass the time.

DO SVIDANYA, Y'ALL

If we overcome all these technical and political hurdles, the day may come when, finally, humankind sets out for Mars. The journey might go something like this: Dateline 2030. Built by the biggest consortium of nations in history, piloted by a multinational crew, supported by an international lunar base, and fueled by propulsion materials mined from the lunar regolith, the huge spacecraft, assembled in lunar orbit, is finally poised to depart for Mars. Supplies are waiting for it there, pre-positioned by unmanned vehicles on the surface of the planet.

To have gotten this far is a triumph of technological wizardry. But even greater is the political triumph. Persevering somehow through four decades of national rivalries, budget crunches, and conflicting priorities, the participants have built cooperative institutions and techniques for managing conflict that may look oddly like the nucleus of a world government. History may note that in going to Mars together, the world finally discovered how to work together on Earth. ☒

BODY

CONTINUED FROM PAGE 22

a glint from the reflection off the cornea. Because the glint is a direct reflection of infrared light, it remains stationary, but the bright eye—an *indirect* reflection of light bounced off the retina—fills the pupil and moves as the person shifts his gaze. The camera tracks the distance between the center of the retinal reflection and the center of the glint to determine the exact spot on the screen the user is focusing on—his "gaze point." When the user's gaze point remains steady for half a second, it signals the digital image-processing card in the computer to comply with the command on that area of the screen, much as a Macintosh user might move and click his mouse.

Hutchinson has already produced six ERICA systems in his lab within five years, he says. He hopes to miniaturize the unit so it can control a motorized wheelchair and go wherever its user goes. In 1988 U Va licensed the ERICA design to LC Technologies of Fairfax, Virginia, the company calls its model the Eyegaze System and has already sold nine of the $25,000 units. According to company owner Joseph Lahoud, further applications include installing Eyegaze in operating rooms so surgeons can call up computerized information using only their eyes.

IBM recently unveiled *SpeechViewer*, a program developed to motivate deaf and speech-impaired kids—and adults—to use their voices and speak clearly. *SpeechViewer* teaches them to translate graphics into sounds, form understandable vowels, and modulate their voices using colorful displays like balloons that expand as voice volume increases, thermometers that register pitch, and trains that indicate the onset of speech. Another IBM device still in the research stage could help profoundly deaf kids make the jump from American Sign Language (ASL) to reading written speech. Deaf kids tend to have a tough time learning to read because ASL and English have different grammatical structures and they can't *hear* where one word stops and another starts. The new system features a touch-sensitive screen that lets the user ask questions by touching the puzzling part of a story. If he's still confused, the program signs the response, much as closed-caption TV programs feature simultaneous translation into ASL.

On a strictly human level, the new computers work miracles by improving kids' lives. "A lot of kids in special ed have only learned to fail over and over again," says Dr. Linda Tsantis, senior planner for IBM's Washington Center for Technology in Education. "Through the combination of technology and software, they suddenly find themselves succeeding—and enjoying it."

Leah, a child whose cerebral palsy prevents her from walking, talking, or even sitting effectively, might have been one of those who never tried. But in first grade she began participating in a pioneering experiment to permit word processing without hitting a keyboard. The approach worked. Today Leah is an active member of her junior high school class. The program she used, called *Kid Word*, runs on an Apple IIe computer. Leah controls the computer by leaning the side of her head against a single switch mounted on her wheelchair's headrest. An adaptive firmware card—hardware that tricks the computer into thinking the switch is the keyboard—scans the alphabet in groups of five letters when the desired group is highlighted, a gentle touch of the head activates the space bar and selects that group. The program then scans the letters inside the group. The first sentence Leah tapped out—at the age of six: IT'S ABOUT TIME.

Further down the line, kids may wear baseball caps that activate computers, says Paul Snayd, special needs program manager for IBM. With the cap aimed at the screen, a slight movement of a forehead muscle could enable the user to select an item from those scrolling past. "The head is the last place to lose muscle control," Snayd explains, "so children who can think but not move could use the computer." ☒

CREDITS

Page 4 clockwise from top, Bernard Dunn, Greg Munchess, Movie Still Archives, Michael Carroll; **page 8 clockwise from left,** Gary Lillien, Mark, Gary Lillien, Gregg Mancuso, Gary Lillien, Gary Lillien; **page 14,** NASA/Robert McCall; **page 18,** Michael Carroll; **page 20,** NASA/John Frassanito; **page 22,** Bruno; **page 24,** Steven Hunt; **pages 26 and 27 from left,** Scott Ransom/Photo Researchers, Rani Levy, Myron Wood/Photo Researchers, Movie Still Archives; **pages 28 and 29 from left,** Movie Still Archives, Bettmann Newsphotos, P. Kirk Visscher/University of California, Riverside; **pages 30 and 31 from left,** Shirley Richards/Photo Researchers, John R. Brownlie/Photo Researchers, Movie Still Archives, Kenneth Murray/Photo Researchers; **page 32,** Movie Still Archives; **page 36 top left,** Jerry Flynn/Rob Aumenuk; **page 36 top, center, and bottom right,** McDonnell Douglas/Kennedy Space Center Division; **pages 40 and 41,** Greg Munchess; **pages 42 and 43 clockwise from left** Movie Still Archives, Robert Brosch Archival Photography/courtesy of United Artists, Memory Shop West/courtesy of United Artists, Memory Shop West/courtesy of 20th Century-Fox Movie Still Archives; **page 44 clockwise from top left,** Robert Brosch Archival Photography/courtesy of Universal Pictures, Robert Brosch Archival Photography/courtesy of Republic, Robert Brosch Archival Photography/courtesy of MGM, Robert Brosch Archival Photography/courtesy of Mono Gram Pictures, Robert Brosch Archival Photography/courtesy of Paramount Pictures, Movie Still Archives; **page 45 clockwise from center,** Robert Brosch Archival Photography/courtesy of American International Pictures, Robert Brosch Archival Photography/courtesy of United Artists, Robert Brosch Archival Photography/courtesy of International Pictures, Robert Brosch Archival Photography/courtesy of 20th Century-Fox, Memory Shop West/courtesy of Universal/International Pictures, Robert Brosch Archival Photography/courtesy of Lippert Pictures, Inc., Movie Still Archives, Memory Shop West/courtesy of American International Pictures, Memory Shop West/courtesy of Columbia Pictures; **page 46 clockwise from top right,** Memory Shop West/courtesy of United Artists, Robert Brosch Archival Photography/courtesy of Spartan, Memory Shop West/courtesy of Topaz Film Corporation, Movie Still Archives, Memory Shop West; **page 47 from left,** Robert Brosch Archival Photography/courtesy of United Artists, Movie Still Archives; **page 68,** Bernard Dunn, **pages 73 and 74,** Movie Still Archives; **page 75,** Rani Levy; **page 76,** Jim Herter; **page 90,** NASA; **page 100,** Ketchum Public Relations; **pages 102 and 103 clockwise from left,** Technical Solutions, Gary Lillien, Jean Walker/Walker Wingsail Systems, Sear Synamics, Gary Lillien, Jason Empire; **Correction, May 1990: Page 30,** Ernst Wrege/Space Art International.


SALVAGE
& SCRAP
B CURRY

CONTINUED FROM PAGE 64

Faber: As an only child growing up in Cleveland I found that science was as natural to me as breathing. I had a microscope, looked at tiny pond animals, thought about dinosaurs, and lay in my backyard, looking at the night sky through binoculars. My parents' older friends asked what I wanted to do when I grew up. I said be an astronomer. I thought the information in children's books on astronomy was coming by magic or from giants like Einstein. It never occurred to me that people in real jobs were getting paid to discover what was in the books.

In an entrance essay for Swarthmore, I said I wanted to discover the origins of the universe and why it's the way it is. To do this, I wrote, you could study large-scale features, like galaxies. But you could also deduce its basic physical laws from a microscopic examination of nature. Swarthmore accepted me and I started out majoring in the small-scale stuff through chemistry. One day I went to see the old observatory, built out of Pennsylvania fieldstone. I came through an old-style classroom to climb some creaky stairs. At the top I found a domed room maybe fifty feet across. In the middle was a long gray telescope—a classic refracting telescope. I can still remember that rush of excitement. At that moment I knew I would be an astronomer. I started observing at nights, more entranced by the vistas in the sky than by the chemistry lab. In retrospect I think I made a mistake. In trying to come to grips with cosmology now, I'm paying the price for not having pursued the underpinnings of it all—particle physics.

Omni: Yet Stephen Hawking says the answers will come from astronomy, since particle accelerators can never reach the temperatures at the Big Bang.

Faber: But the thinking and creative urges are coming from the physicists. They're using the tools astronomers have developed to prove their theories. I left physics in the late Sixties because it seemed like a zoo of unrelated and unsatisfactory theories. I didn't know great minds at that moment were thinking of unifying forces and concocting grand unified theories. [University of Texas physicist] Steven Weinberg at that very point was doing the work that would win him the Nobel prize, but his ideas had not trickled down to classes at liberal arts colleges.

Now comes the marriage of astronomy and particle physics to produce a new cosmology. We like to sum up the idea with the image of Ouroboros, the ancient symbol of the snake that swallows its tail. The head represents the whole universe. On its throat are painted superclusters of galaxies, then galaxies. Moving along its body in powers of ten are stars, planets, then atoms, protons, and quarks. Near the tail we reach the realm of quantum gravity and the particles of the grand unified force—the first instant of the universe—where the tail goes into the snake's mouth. By knowing the very small we account for the very large.

Omni: Do you believe the universe evolved from nothing?

Faber: In general relativity, if you run time backward, the logical consequence of the expanding universe is a mathematical point with absolutely no physical size or interior structure: a singularity. I don't regard that as real but as a question mark. It is a space so small that we don't know what's going on inside. The point is something on the order of the Planck length, ten to the minus thirty-two centimeters.

Omni: So something existed before the Big Bang?

"Astronomy makes a difference if people carry this image of a tiny Earth floating in space next to a small star, light-years away from outside help. We are very much on our own."

Faber: To say what happened we need a theory of quantum gravity that tells us what goes on inside the Planck length, and we don't have that. But we do know that very funny things happen in tiny spaces on short time scales, even in vacuums. Virtual particles [each consisting of a particle and its paired antiparticle] appear and disappear continuously in sort of quantum fluctuations. It's a violently active medium, and we think the ylem [Greek for primordial stuff] was also. Princeton physicist John Wheeler has called it space-time foam. By these same sorts of quantum fluctuations, things appear and disappear in this foam. I think the region that made the universe was like a virtual particle that happened to survive. It appeared, and by great good luck, its properties and physical laws allowed it to evolve away from a tiny instability into the universe we call our own.

Omni: Is ours the only universe?

Faber: Say we develop a good quantum gravity theory, take our physical laws, and find out there is an ylem. We might discover that all universes must have the same laws and look essentially like ours. Or we may find out there are a zillion ways to make things. Who's to say the mass of the proton has to be 1.6 times ten to the minus twenty-four grams? Maybe it could be 1.5 times ten to the minus twenty-four without messing things up. Maybe you could have a six-dimensional space-time instead of four or three different kinds of time. Then the metauniverse, this whole collection of universes, could have an infinite number of examples. Ours is picked out merely by our existence in it, just as the earth is selected among all possible planets by our being here. Russian physicist André Lindé's picture of what we call eternal inflation leads you to universes that beget universes, each going through its inflationary stage. It's like an infinitely branching tree, with each universe budding out of a precursor. Little universes appear all over the place. There are probably fluctuations that start with too little boost, collapse, and disappear; others that expand but could never contain life.

Omni: Could we find evidence of a coexisting universe?

Faber: I used to think of the universe as everything that is. I now think of it as all regions of space-time accessible to me, given infinite time to visit. Say two people in our universe fall into separate black holes. They can never come back out and visit each other. I think of each universe in the metauniverse as finite, something like a black hole, a region of trapped and localized space-time. If that's how it is, we might never be able to get observational evidence of other universes. It would have to come from sheer logic.

Omni: If our universe is finite, will it collapse sooner or later?

Faber: I have a hard time embedding an infinite and open [forever expanding] universe in the metauniverse, but maybe it's mathematically possible. However, if it's slightly closed [destined to collapse], this leads naturally to a finite geometry separating us from the surroundings of the metauniverse. Measurements will likely never answer the famous question: Is the universe open or closed? In his classic paper on inflation, [MIT physicist] Alan Guth [see Interview, November 1988] said that omega [the ratio of expansion rate to gravity of total mass] should be close to one, like about .999999 out to fifty or sixty decimal places, or just over one. Inflation says we are close to omega equals one, but not whether we are above or below. We'll never have the tools to measure so precisely. So we can never find out by direct observation. Maybe the metauniverse theory will show that a universe like ours must be slightly overdense [closed] to exist. Then ours should collapse at some time unless some effects of our connection to

the metauniverse outside prevent it.

Omni: How did quantum fluctuations create galaxies?

Faber: Here we are on firmer ground. In the instant the fluctuations existed, the universe was inflating faster than the speed of light. Before the fluctuations could die away as they normally would, the universe blew them up to macroscopic size and they got frozen in, creating clumps of higher density.

As the universe exited from inflation, it was a dense gas filled with radiation and particles at a temperature around ten to the twenty seventh kelvins. The fluctuations couldn't grow then because gravity came mostly from photons [light rays] that don't collapse under their own gravity. Gradually the universe cooled, leaving ionized [charged] hydrogen, helium, and their electrons trapped in a matrix of photons. Further cooling to about three thousand K brought the universe to a watershed event called recombination. Here the universe—about one thousandth its present size—went from opaque to transparent, from ionized to neutral. Matter particles broke free from photons; their gravity began to dominate, and all of those lurking fluctuations saw each other for the first time! That is, their enhanced gravity started pulling in nearby particles in a runaway effect. A little pull of gravity grew and grew in the direction of bigger density. The dense regions clumped together into galaxies in the still-expanding universe.

Omni: Does this clumping continue?

Faber: Yes, we think this process will make even larger aggregates for a long time, perhaps as long as the universe expands. Gravitational instability occurs on all scales, like big and tiny waves in the ocean. The little instabilities collapsed first to make galaxies. The galaxies fell together into clusters. Then later the clusters collapsed to make superclusters.

Omni: How do the Seven Samurai try to measure this vast streaming of galaxies toward a Great Attractor?

Faber: When the microwave background radiation was discovered in 1965, everyone asked: Is this left over from the Big Bang? We know it's light from an early time when the universe was as bright as the surface of the sun. The radiation isn't entirely uniform. In one direction it's bright, in the other direction it's faint. People realized it was the dipole effect of our galaxy streaming through space.

Omni: The dipole effect?

Faber: Imagine you're flying through an immense room filled with mosquitoes. The cloud of mosquitoes is at rest with respect to the walls; otherwise the cloud would move through the walls. If more mosquitoes strike you when you face in one direction, you know you're moving and can deduce the speed by how fast they hit you. The dipole effect is like that. We are getting more microwave photons from one part of the sky because our galaxy is moving through space in that direction. Think of the background radiation as particles uniformly carried apart from one another by the expansion. Their constant uniform motion with respect to one another defines a co-moving rest frame. And the peculiar motions of galaxies can be measured against it. We know how fast the earth goes around the sun and the sun goes around the center of the galaxy. We have a guess at the speed our galaxy goes through the center of the Local Group [of some 20 neighboring galaxies]. Knowing these velocities, we can calculate the motion of the Local Group against the microwave background: six hundred kilometers per second [1.3 million mph] off in our Southern Hemisphere. That's a hefty motion.

People once thought the nearby cluster of galaxies called Virgo was the attracting mass. But it was found to be moving, too, and its pull is in the wrong direction. For more than five years we've studied the distances and

peculiar motions of about four hundred galaxies out to several hundred million light-years. We suspected the attracting mass might be Hydra–Centaurus, the next closest supercluster. But we discovered it, too, was falling toward an overdensity even more massive and farther away. The mystery mass is called the Great Attractor. But the motions themselves are not a mystery. They occur simply because matter is not uniformly distributed. The dense places pull harder, the empty places pull less. The streaming motion is caused by gravity.

Omni: What is dark matter?

Faber: Astronomers think only about ten percent of matter in the universe comes from the hot hydrogen and helium of the primeval fireball that made the stars and then cooked inside of them to become carbon, nitrogen, oxygen, you and me. If we observe a cluster of galaxies and add up the luminous mass in their stars, we discover that it should fly apart—unless it's bound together by much more gravity coming from mass we can't see. Also, the stability of spiral galaxies can be explained only if they're embedded in a halo of dark matter.

That dark matter *does* exist will likely endure as one of the major findings of modern astronomy. Many people think it's a new elementary particle. If so, it should be everywhere, even here, coming through the walls. But we can't see any sign of this stuff; experiments fail to detect it. How can this be? It's probably collisionless, like the neutrino that can go through six light-years of lead before colliding with another particle. So it passes right through the detector. When an experiment out of the Soviet Union claimed to detect mass in the neutrino, it became the leading candidate for the missing mass. This came to be known as the theory of *hot* dark matter.

Omni: That was a theory you helped shoot down.

Faber: Yes, I helped write the first paper on galaxy formation in a *cold* dark matter universe. I've been extolling the joys of this theory, and it has become the paradigm, if you will. The particles of these competing theories are not really hot or cold. At the high temperatures of the early universe, all particles become relativistic. They get excited to velocities near the speed of light. As the universe expands, it cools to a temperature where the heaviest particles slow down; we call them "cold." The lightest particles are still excited and rush around at the speed of light. These are relativistic, we call them "hot."

We studied a three-component brew of photons and ordinary and cold dark matter. As long as you make the dark particle collisionless, its mass tells you what fluctuations it made in the early universe, and the kinds of galaxies and clusters you should see today. The interesting masses fall into two distinct sizes: the hot one in the range of the putative neutrino, say, three electron volts up to a hundred; the cold mass is up near the mass of a proton, one to five billion electron volts. Remember, these particles can't collide, so they aren't trapped in the photon matrix as charged particles are. At around a billion degrees the hot particles are still relativistic—rushing around. If the hot one makes a fluctuation, it and its gravity just evaporate as the relativistic particles just free-stream away at the speed of light. Structures needed to make galaxies just go poof. But the cold particles are moving too slowly to escape [their own gravity], and their fluctuations endure.

If you look at computer simulations of the two scenarios, the cold dark matter universe looks much more like the real thing. Hot dark matter does not make the majestic spiraling galaxies we see. A hot dark matter universe would have incredibly thin walls of galaxies. With cold dark matter so many things match our observations: the size of galaxies, their rotation speeds, the clustering, and the voids.

Omni: But you raise doubts about the cold dark matter theory, too.

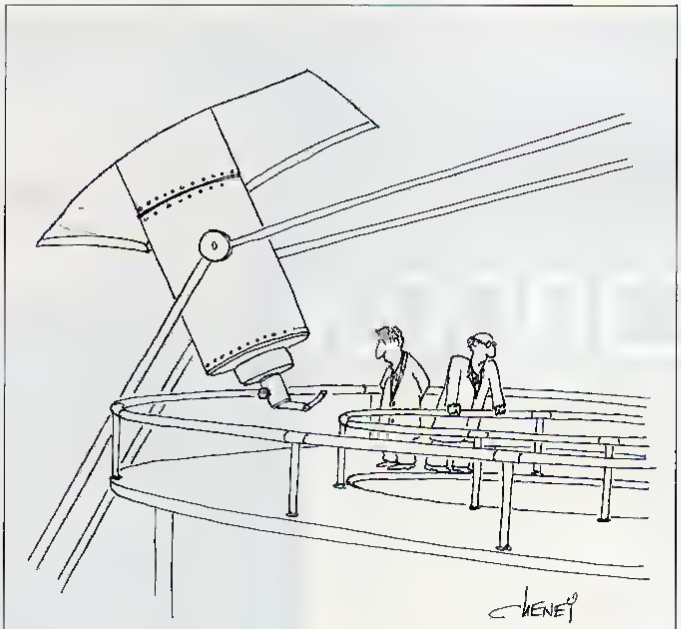
Faber: Unfortunately, yes. We predicted how far along clustering should be on every scale and predicted the large-scale flow velocity with cold dark matter. After the Great Attractor studies, though, people began asking how likely it is that such a big patch of the universe should move so fast. It's very unlikely. The Great Attractor should not exist in a universe evolved from cold dark matter.

Omni: What gives?

Faber: Well, suppose the dark matter isn't just one kind of particle but a mixture of hot and cold. The hot dark matter particles give more oomph to the large-scale density fluctuations [like the Great Attractor] and match the velocity of Great Attractor flows. And the cold dark matter nicely makes galaxies on the small scale.

In one recently proposed model, the dark matter consists of one massive particle roughly two times the size of a proton and one light particle about three electron volts, big enough that it might be detected someday. The neutrino with very little mass is a good candidate. Some people find this hot and cold mixture very ugly. But physicists have so many candidates for new particles that could exist; why should the unseen matter magically be made of just one particle?

Omni: When will your observations give you answers to the big questions about the universe's origins?



"I can accept the fact that we haven't seen anything new in the past five years. What I can't accept is that no one ever removed the lens cap."

IT CAME FROM OUTER SPACE.

The wheelchair you see here is made from a super lightweight material developed for space vehicles.

It weighs half what a standard chair weighs. Yet it's just as strong. And a lot easier to maneuver, fold up, and store away. It promises to provide wheelchair users with a far more comfortable way to get around.

This innovation for disabled persons is just one of the down-to-earth applications of space technology. To find out more about it, call the U.S. Space Foundation at **1-800-255-1000.** Or write to: United States Space Foundation, P.O. Box 1838, Colorado Springs, CO 80901.

SPACE TECHNOLOGY. THIS IS WHAT'S IN IT FOR YOU.

Faber: When we can see back far enough. Looking out to a distant galaxy, we see back in time, the time it takes the light to reach us. If you strain to make out the Andromeda galaxy, the most distant object visible to the naked eye, you look back two million years. With a good-sized telescope we can look back ten billion years. If you point this telescope at random into the night sky and take a picture, you see a few fuzzy things on the photograph. But mostly it looks blank. If instead of film you use a vastly more sensitive CCD [electronic charge-coupled device], suddenly the same sky is alive with faint blobs of light. The entire celestial sphere is filled with them—a hundred billion strong, so thick their images overlap. We know they're outside our galaxy because they're too faint and numerous to be local stars.

The theory of cold dark matter predicts that galaxies agglomerate out of many small fragments. With new instruments we will soon look back a crucial two or three billion years or more—to a time when all the pieces of the galaxies haven't fallen together yet. So they should be smaller and there shouldn't be a lot of them. I hope these blobs of light are galaxies forming. If we can see them clearly, we'll begin to understand in exquisite detail how structures in the universe form. This is the work of the next twenty years.

Omni: With the perfect telescope, how close to the Big Bang could you see?

Faber: Looking back in time, we see through a clear space for a long way. But then we come to this wall, the cosmic background radiation when the universe was as hot as the surface of the sun. We cannot see through it, we can't see beyond it to the first three hundred thousand years or so.

Omni: What will the Hubble Space Telescope do for astronomy?

Faber: For decades we've dreamed of putting an optical telescope above the image-smearing atmosphere. While the Hubble's primary mirror is only of average size, about ninety-five inches in diameter, it will give us images ten times sharper than we get from Earth. It will also sample ultraviolet wavelengths that don't reach the ground, so we can study young stars.

We should see stunning detail in all kinds of celestial bodies. We may be able to tell if quasars really are black holes, shining as they swallow up gas, and if black holes exist at the center of nearby galaxies.

I'm part of a team that will finally measure the Hubble constant, the scale size of the universe. When we observe a galaxy that's moving four thousand kilometers per second, we want to study its structure, how big it is, how much it weighs. For the first time we'll measure really accurate distances to galaxies and learn much more precisely the age of our universe.

Omni: To you, the universe is so vast it's mind altering. The Milky Way just a pinpoint of light. Do planets around nearby stars seem insignificant to you?

Faber: I think of superclusters of galaxies out to six hundred million light-years as fairly insignificant. Earth and humankind strike me as minor events. Still, I have a feeling of oneness with the universe as it unfolds in such a stately manner. In a deeply satisfying way, one event has led to another and here we are—the product of what seems in retrospect to be an inevitable process. Another universe might be different, but in ours people are a natural phenomenon. From quantum fluctuations to galaxies that obligingly made stars that cooked hydrogen and helium into heavy elements that formed solar systems and planets with water—it's perfect!

We have every right to feel at home here. And that's what Eastern religions are all about, the unity of everything. I once got a letter from a Christian Fundamentalist unhappy with my account of the Big Bang and evolution of the universe. She said it ruined the beauty of the Old Testament story for her. She sent me Xerox copies of the Bible with particularly lovely passages underscored. It got me thinking. We scientists are talking about fluctuations at ten to the minus thirty-two centimeters that grew up to make galaxies. Talk about beauty! Talk about awe inspiring! The modern story of creation is infinitely more subtle and grand than any creation myth. The language is beautiful in Genesis, but the thoughts are essentially mundane.

But there *is* one neat thing. It says in the beginning there was light. That's actually right!

Omni: What difference does astronomy really make?

Faber: It doesn't put food on the table. It did give us the atomic bomb, though some people don't like that much. Astronomy is basically *ideas*. I listened to a priest some weeks ago on a radio program. He said he was rejecting traditional religion because it didn't help him deal with the most pressing moral problem of the world—to what extent we should destroy the planet to have the life-style we want. He was profoundly moved to find that we came out of the stars. This helped him see that we are just a little planet and that we've got to preserve our future all by ourselves. It's a long future—billions of years if we choose to be around. Astronomy makes a difference if people get a gut level feeling for our long history and our separateness, if they carry around in their heads this image of tiny Earth floating in space next to one small star, light-years away from outside help. We are very much on our own. ∞

COMMUNICATIONS

CONTINUED FROM PAGE 10

From Russia With Love

Thanks to the agreement between the academic magazine *Science in the USSR* and the widely read American *Omni* magazine, we now have the opportunity to receive and read this popular magazine. I have had the pleasure of reading it and would like to thank you for your easy reading style.

K. M. Dubachev
Vice-President
USSR State Committee
on Science and Technology

The agreement between *Omni* and the Soviet-published *Science in the USSR* to circulate one another's magazines is a bright example of the widening cultural exchange between the USSR and the United States. I am fortunate to receive both magazines, their scientific value is accompanied by recommendations on inventions and discoveries.

V. A. Bykov
Minister of the Medical
Industry of the USSR

I read all of *Omni* magazine with great fascination. I think that it is one of the most interesting magazines that I have ever seen. I learn a lot of information from it. I'm very interested in environmental problems, so I find your many articles devoted to this issue particularly interesting. The fiction, paintings, advertisements, and illustrations are delightful. *Omni* strengthens my faith in human intelligence and helps me to believe that in the future scientific and technological progress will improve living standards in our country.

Igor Stefanovich Konovalov
Rostov-on-Don, USSR

We are two of your readers from the USSR. We live in Leningrad, where you can buy the Soviet *Omni*. We like *Omni* because it features interesting discussions about problems mankind may face in the future and how certain people propose to solve them. Many of these problems are important for the Soviet people as well as Americans. We want to correspond with our American friends so that we can all understand one another better. Now some words about ourselves. Andrey is eighteen years old and a student at the Leningrad Shipbuilding Institute. He plans to be an engineer. Please write to him at st. Tchaikovsky 50, Apt. 43, Leningrad 191194, USSR. A student at Leningrad State University, nineteen-year-old Paul is studying to be a sociologist. He can be reached at pr. M. Toreza 2/40, Apt. 40, Leningrad 194021, USSR. Thank you for all your help!

Andrey Anoshko and Paul Rozanov
Leningrad ∞

CONTINUED FROM PAGE 71

goods coveted by the Information Revolution's arrivistes: jewels and perfumes, elegancies of cloth and design, and most perverse of fabulations: the automata. But with the passing of the *aube du millenaire*, Europe's fashion masters were confronted by a world increasingly fickle, increasingly philistine. Japanese disinvestment prompted recession, and from the Atlantic to the Urals the continent was eclipsed by foreign vulgarizations of its genius.

James was very still. I rested my head on his shoulder. Like so many of his kind, he'd come to ask the sweatshops of Bangkok to provide consolation for his lost toys. Outside, tattooed upon towers of glass and jade, vast holograms of Buddha recalled the transitoriness of all things.

"I can do it, James."

"I used to have a collection. Even as a child," he said, in childlike reverie. "Being without them these last few years—" And those cold, gray eyes softened. "It's been hard," he said, "hard." His flesh was hard. I felt its panel-beaten contours through the cool silk of his Italian suit, and on tiptoes I sought his mouth. He arched an eyebrow, his face hectic with the effort it seemed, to at once express irony, contempt and desire. "So little Mosquito wants to be my R and R?"

"I want—I want to be your doll." I pulled his head down and found his lips. "Please," I said, "I want to be part of your collection."

"Cartier? Tonight?" he mumbled.

"Yes," I answered, "anything." And not unreluctantly, he allowed me to kiss him. In time I was sure I could make him love me.

A *tuk-tuk* sped me along the Sukumvit Road. Before leaving I'd thrown on a skirt—just long enough to conceal the bifurcation of my thighs—and put in my green luminous contacts, trademark of a Cartier doll. I had arranged to meet James later at the Honey Hotel, where I'd present him with my catch. Nana Plaza would be my hunting ground.

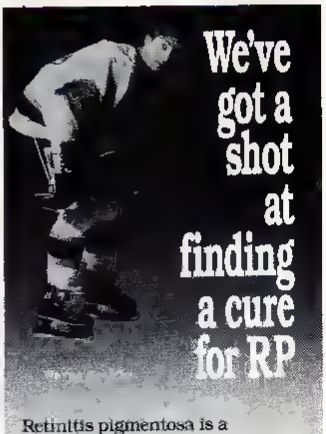
At Soi Asoke I hailed a long-tailed boat, the klongs having reclaimed much of the city, making it once more the Venice of the East. The taxi churned the dark waters of Sukumvit, scattering the reflected images of pagodas and shopping malls that sat like peroxide lilies on a black pond stained white by the city's glare. The traffic thickened, and before me rose Nana, a gigantic lily pad, pale and bright, a night bloom releasing its bouquet of sex into the smog-filled air. Above, an insect susurration. Autogyros caught like moths in searchlights panning the sky were falling to earth in swarms, unloading cargoes of sweet-toothed breeders eager for Nana's delights. I paid my ferryman and alighted.

Nana was doll city: very gynoidal, very het. It still possessed some of the shantytown ambience of sixty years ago, when it had soothed the nightmares of American GIs; but now superimposed upon its skyline of poured concrete and twentieth-century slum were undulating whiplash curves and geometric lines copied from the European Art Nouveau and Art Deco renaissance of the *aube du millenaire*. This stylistic heterogeneity was exemplified in the person of Nana's mammasan, Madame Kito. Kito, the daughter of a *farang* and a doll, belonged to that caste of half humans we called *bijouterie*: hybrid jewels as distinguished from all-precious *joaillerie*. Ostracized by humans and automata alike, *bijouterie* lived as pariahs, envying and hating those whose holistic integrity so rebuked them. Whenever I came to Nana, Kito's lonely, jealous, violent heart called to mine.

I moved through a confluence of dolls. A few repros were at work—ball-jointed, porcelain-skinned "antiques" who offered their brass umbilical keys to passersby—as well as a handful of aboriginals—nonreflective pieces of walking, talking AI, who, like Zipper, were from a time before nanotechnology replaced microelectronics. In one doorway a matching pair of crystal torsos—Lalique?—displayed, like deep-sea tropical fish, neural networks of polychromatic liquids. (The opposite, of course, of most configurations. Dolls, like my favorite candies, are usually soft on the outside, hard within.) But enough of Nana's denizens approximated my own design for me to cruise the doll-saturated streets in anonymity.

Walking with a gynoid's sexual precision, I checked off each bar name, seeking my prey. There was House of Dolls, Tin Lizzie, Columbine's, Club Puberty, and an S&M parlor, Judy's. Some crew cut boys eating at a noodle stall called out, "Where you going, pretty sex doll?" and "Over here, clockwork *poo-ying*." Ahead, the bar I sought signaled its wares via a sign featuring neon-green eyes beneath which, in Gothic script, flickered WILLY HOFMANNSTHAL'S DOLL KELLER. Willy was a Cartier aficionado.

In the acid noon of the Keller's light show, amber-skinned dolls with incongruous jade-green eyes performed, in bamboo cages above my head, their generic dance, The Lordosis. Many of these girls were state-of-the-art Cartier *poo-ying mee ow* (or, in European nomenclature, *Felis femella*), the results of cross-species genetic splicing. They sported whiskers, tails, and pointy ears or else were leopard-spotted or



striped like tigresses. Compared to them my reshaped lines were passé. But Willy's dolls seemed unconcerned. They were too busy lifting beer glasses to the lips of their *farangs* and prattling their babyish subtongue, their programs—inspired by an aesthetic of cuteness—stage-managing their mimes of little-girl adoration. I found the number one girl and told her I had a message from Madame for Mr. Willy. I was led upstairs. He was an old man, sitting on the bare boards of a room naked but for a rice-paper screen. On his knees was a laptop. The green spectral light of its VDU had him mesmerized. I coughed; his head turned with a rheumatic scrunch, and while his watery eyes focused on my loveliness, the powder-blue visage of a cat peeped inquisitively from the folds of his dressing gown. He stroked its head. 'Ah, Gudrun, one of your sisters has come to call. What can we do for you, Miss Cat?"

'Madame Kito want doll. She have friend come stay. *Yakuza*.' The pornocracies guarded their dolls well (when renting a doll a *farang* was required to leave his passport with the bar as surety), but in the six months I had doll-rustled no one had called my bluff. Willy would be an easy sting.

"Kito, Kito. Always Kito," he sighed. "It isn't fair, is it, Gudrun?' The cat jumped from its silken enclave to bathe in the laptop's green effulgence. 'It all used to be so different. But home is so far, far away. . . Do you remember what it was like, Gudrun? This doll here—competent workmanship, but a quasihuman structure like the rest. Unredeemed carbon! Now, I remember real Cartier dolls, *joaillerie* whose insides gleamed with jewels and ivory, platinum and gold. But Thai protein engineers have no skill with ribosomes or RNA. No skill with catalytic antibodies. They just shuffle the genome, or what little they know about it, then pin it all together with polymers and steel. They do not understand the alchemy of the flesh! In Europe, Gudrun, we build atom by atom, nanocomputers controlling molecular tools to make gears, motors, levers, little molecular-sized components that have the same kind of structure as metals and stones, ceramics and resins, each one programmed to replicate itself, to take its place in the divine clockwork. . .'

His spine had become upright and his body spasmed, as if galvanized by an unseen puppet master. Long, skeletal fingers tapped the keyboard, and as from a magic lamp, a hologram materialized above us, glowing like ectoplasm in the darkened room. It was a cutaway diagram of a gynoid, its flesh stripped away to reveal its brazen ingenuities. Slowly it began to revolve. "Tabitha. My *kleinkunst*. In whose arms do you lie now? Oh, Gudrun, she was so very beautiful. Look! What architecture! What supernatural clockwork! Peerless somatics, faultless autonomics. The sacrum, the ilium, the acetabulum of chrysoprase, mother-of-pearl and vermeil. The bloodstones of the abdominal aorta. She was an angel, Miss Cat, a living jewel. Genitalia? Oh, no! Not like these imitations made today, just sex, sex, sex. She was an angel. . . " He passed a hand across his face. "All the money, Gudrun, that our science gave us, spent on status symbols, arts and *objets* and toys. Now we *farangs* have forgotten how to make anything except toys, and nobody wants to buy them, Gudrun, nobody wants to buy.' The hologram continued to revolve, like a ride in a deserted fairgrounds.

"Madame Kito . . ." I ventured.

"Yes, Miss Cat, I know, I know. A doll for Madame. Take one. They took my doll a long time ago. My Tabitha. My Tabs. They cannot harm me anymore."

Through the streets we walked, two cat girls arm in arm, invisible amid the midnight crush of Nana. I had chosen one of Willy's more conservative models. *Felis femella* is difficult to smuggle. I looked at my companion. Why did James want her? A biochip-and-steel glycerin-hulled fake? Her scent was cheap. Her makeup overdone. How could her sexual obviousness, her sensationalism, console him for the loss of a genuine Cartier doll? Still the European sons came to Bangkok, their taste either hopelessly corrupted or forfeit to an overweening desire to again possess a mechanical love, however nonpareil. Back in London, tiring of his new mistress, it would be I who Milord would turn to for consolation. And in me he would find a *real* doll.

Soon a water taxi was speeding us through the night's swelter and toward the Honey, where Milord awaited delivery of his *dtook-gah-dtah*.

'Cute,' he said, after he had had her perform a few party pieces and tricks, 'but not a spiritual toy. Not like. . .'

'Like a real doll?'

"Sleep." he told her, and she stretched out on the bed and closed her eyes. The room, brothelscaped in red and gold, was giddy with mirrors. A poster of one of the latest automaton starlets hung from a flocked wall, her flesh transposed to the glossy world of a photomechanical: a 2-D limbo as deathlessly precious as the world of a pressed flower. The poster, like the TV that covered half the ceiling, was interactive and ran *jeux vérités* software. Milord stroked his doll's overextended thighs, as smooth and glistening as yellow wax. 'She'll do. For my purposes.' The photomechanical was sniggering at me. I couldn't see the joke. The air

conditioning was broken the room hot and airless and I needed a drink

"When do we leave, James?'

"Little Mosquito," he said tenderly His leather-sheathed hand reached out to offer a caress I tilted my head, closed my eyes, and saw us together in the rain-shiny London streets His copper-tipped index finger and thumb clasped my temples

'Are you pleased with me?' London melted in a blue-white flash and darkness cold and impassioned slapped me to the floor, tied me up, stood back to watch me twitch and convulse, then embraced me like a repentant lover When I came to, Milord was pouring himself a scotch from the minibar his smoking claw plucking ice from a thermos

'Sorry about the ECT, dear boy, but I fear this really is the only way to say good-bye Don't try to get up Your vertical hold's rather wonky '

I knew I had lost I would always lose Because I'm not the real thing Because I'm not even a poor fake Just a fake of a fake Not even *bijouterie*

How I longed for genuineness

The photomechanical startled by the commotion, had stepped out of frame, now she peeped round the borders of her world angry at having been disturbed from her little death

I just wanted to be your doll Mr James just wanted to be part of your collection But no time for self-pity He loves me, he loves me not So it goes He was just like the rest only prettier Smile Keep him talking This psycho was maneuvering for the coup de grace Delay

"You were supposed to take me with you My lips were as numb as my arms and legs

"What a revolting idea '

"Then let me go There's no need for this I won't tell "

'Oh? And you seemed to have such a crush on me Truly I was flattered "

'I'm not worth it I'm just a romantic fool Why are you doing this?"

'Perhaps you think it's the money? You think I circumvented Harry because I'm a poor, penniless Europunk? It's true, money was a problem once My family had shares in Cartier When the crash came we were ruined I had to sell everything, including, of course, my dolls But now Cartier pays me very well Very well indeed "

'I don't understand "

'Mosquito you don't understand *anything* " He sat astride me, a playground lout, the copper electrodes held tauntingly before my eyes like creepy crawlies he might at any moment put down my blouse Reflected in his monocle I saw a green-eyed little fool my sister, her red-lipped mouth agape in a comic-book cliché of "pain and surprise " Milord was enjoying himself He was a nasty boy

'People seem to prefer the second-rate Copies Imitations We thought at first President Kennedy would help But all he did was pontificate about protectionism and the need for free trade As long as no one pirated American intellectual property Washington didn't seem to care Then Brasilia vetoed us at the GATT The world was flooded with dolls from Bangkok and Manila Why couldn't you have stuck with your radios and TVs, your cameras and washing machines? Why manufacture automata? It was all we had left The only thing that made us special You stole our copyrights our names Cartier, Givenchy Lalique Faberge Coty—all the houses from London to St Petersburg And now we have nothing left But that will change, Mosquito I am if you like part of the vanguard of quality control A recruit to the guerrilla army of taste I buy dolls for the house of Cartier Counterfeit dolls And in Paris Mosquito they *change* them That dolls aren't like their Western originals Nanoengineers here use fetal tissue as a template A *dtook-gah-dtah* is in many respects, remarkably human We have, after all, the evidence of *bijouterie* Car-

fool, my sister, her red-lipped mouth agape in a comic-book cliché of "pain and surprise " Milord was enjoying himself He was a nasty boy

'People seem to prefer the second-rate Copies Imitations We thought at first President Kennedy would help But all he did was pontificate about protectionism and the need for free trade As long as no one pirated American intellectual property Washington didn't seem to care Then Brasilia vetoed us at the GATT The world was flooded with dolls from Bangkok and Manila Why couldn't you have stuck with your radios and TVs, your cameras and washing machines? Why manufacture automata? It was all we had left The only thing that made us special You stole our copyrights our names Cartier, Givenchy Lalique Faberge Coty—all the houses from London to St Petersburg And now we have nothing left But that will change, Mosquito I am if you like part of the vanguard of quality control A recruit to the guerrilla army of taste I buy dolls for the house of Cartier Counterfeit dolls And in Paris Mosquito they *change* them That dolls aren't like their Western originals Nanoengineers here use fetal tissue as a template A *dtook-gah-dtah* is in many respects, remarkably human We have, after all, the evidence of *bijouterie* Car-

flesh transposed to the glossy world o a photomechanical a 2-D limbo as deathlessly precious as the world of a pressed flower The poster like the TV that covered half the ceiling was interactive and ran *jeux verites* software Milord stroked his doll's overextended thighs, as smooth and glistening as yellow wax "She'll do For my purposes " The photomechanical was sniggering

tier Paris set out to bridge the hardware–wetware divide, to write a computer virus that could be transmitted from machine to man . . .'

'Klong fever?' I said, finding my tongue.

'Of course. It's an STD, computer language translated into biology through enzymes, man and machine both share. Every doll, after its program has been infected, is shipped back to Thailand, a man-hungry pathogen. But none of you will suspect. Dolls are supposed to be disease-free. And the real beauty of all this, Mosquito, is that the virus is an ethnic weapon. Only Orientals are affected. It's prejudiced against certain kinks in your DNA, the gene for instance, that gives you those pretty slitty eyes!' He forked his fingers and made to gouge me. I flinched; he relaxed his threat. 'The virus only commandeers cells displaying those idiosyncrasies that characterize your poor, overconfident race. Then the pogrom begins. It replicates, targets the hypothalamus, and creates a hormonal imbalance, causing impotence in the male. In say three generations, your gene pool won't fill a petri dish.'

'Revenge. Is that all you want?' Mr James was a considerable disappointment. 'I thought you had more imagination. More fascination.'

'I want,' he said, wiping a hand across my mouth and smearing my cheek with lipstick, 'to see your industry suffer. I want an end to cheap imports. I want a world I know only as a memory to return, a world of grace, of beautiful automata . . .' The black leather-sheathed hand descended.

'This is too impromptu, Mr James.'

'The others—they were just petty thieves. They didn't have your class. It's a pity you have to share their fate . . .'

And it was then that those same elements of irony, contempt, and desire that I had earlier seen at war in his face reappeared to continue their struggle. He bent down to kiss me. Not merely the will to survive, not merely the bitterness of a jilted heart, but lust, thick and muddy, prompted me to draw back my lips and bite deep, deep, my cruel dental work injecting customized protozoans, my mouth filling with blood and his scream.

He jerked backward, as if shot by a high-powered rifle, and fell trembling and shivering by my side. Already he had passed from a mild sweat to chronic dehydration. His mad, beautiful eyes—delirious with the last stages of malarial fever—regarded me with puzzlement. 'That, darling,' I said, 'is why they call me Mosquito.' With a great effort I managed to sit up so that I was able to cradle his head in my arms. His blood was thickening, turning his brain into a stew. He was so beautiful. One of the most beautiful men I had known. A fatal beauty. 'Didn't you even like me,' I said, 'a little?'

I left the hotel with his Panama over my eyes, and with my mouth still filled with the saline taste of blood, still echoing with his scream. His voluminous clothes undermined any attempt at inconspicuousness. But the concierge had seen a doll enter, a man leave. After they had found the body, they would ponder how a Cartier doll had come to murder her client, they would open her up, look for faults, scratch their heads, destroy her, they would forget about the ill-dressed man.

In the small hours, above the Gung-Ho in Harry's private rooms, I changed into some spare he-clothes and sprawled out on the sofa while the boss quizzed me about those new Seiko dolls I was supposed to have checked out. I lied fantastically. I was in no mood to talk of mad *farang* scientists and their poisonous girls.

'That Englishman,' he said, after we had finished a bottle of Mekong. 'Hear from him again?'

'No.' I flushed, but the shadows hid me. It was not shame, of course, but embarrassment. I had been such an idiot.

'Good. Why is it always Englishmen with you, Mosquito?'

'Because . . .' But I was so tired. Tired of this ridiculous body, this extravagant heart. A fly droned lazily in the torpid confines of the lounge; moonlight was seeping through the blinds. I remembered another moonlit world, the land of ice and snow where once, I had been happy. Even in the last days of empire, it was a land of masques and bergomasques of enchantment, of moonlight calm, sad and beautiful. Life then was a long *fête galante*, a fairy tale. I had wanted to be part of that marvelous world, that land of satisfied desire, part of its genuineness. More than a woman, I had wanted to be *joaillerie*. They were not like their Eastern sisters, but elegant courtesans with the most ethereal of manners, the beloved mistresses of lords, the trusted confidantes of ladies.

I sometimes think I shall never return.

'I'm through with Englishmen,' I said. It was doll world, not they, that I had been enamored of. Ah, I am a fake of fakes, an impostor, my life a banal porno flick, a cheap *jeu vérité*. But sometimes, half awake, half asleep, I dream that I have put off this unwieldy flesh, that more than a woman, I have become a doll. A real doll, beloved of princes and kings.

'My funny valentine,' laughed Harry. 'We'll have another customer tomorrow. Another Englishman, perhaps. Go. Go home. Go home to Zipper. Go on, before I break your arms. Go home to bed.' And I did. But the dream, unreal as love, persists. ∞

SPACE

CONTINUED FROM PAGE 20

get an accurate reading of the grade with its rudimentary black-and-white camera, the black ant lifts a foreleg, sets it slowly down, down; it does the same with its other foreleg, then lifts a middle leg—and goes sliding, sprawling, flailing into the eye of the Face.

In the red dust at the crafer's bottom, the black ant methodically lifts each of its legs, its accelerometer still gauging the pull of gravity underfoot. But the accelerometer was actually broken by the fall, and the black ant is turned on its back, where it lies helpless and unable to right itself. The black ant rests in deep shadow futilely sending a homing signal until its solar battery runs out.

And *Rover* goes, constantly checking its wheel encoders, which measure its relative position and orientation, and inclinometer against the traverse plotted by ground control. Eight radio signals are beeping at *Rover*, but only seven ants clamber down the west side of the Face to wait patiently as *Rover* pries open their sampling claws.

Though *Viking* was billed as 'the search for life on Mars,' the mission proved inconclusive. If there is—or ever was—life on Mars, *Rover* can find it. With a differential scanning calorimeter (to measure the temperature of mineral samples), a high-resolution optical microscope, and an advanced gas analyzer (to determine the composition of volatile compounds), *Rover* is a rolling laboratory, capable of finding any carbonic remains or soil microbes that might have eluded the earlier search.

Finally *Rover* hoists the ants onto its back and rolls onward to the primary target, the tests under way inside its belly. *Rover* will not know whether it has discovered life on Mars: it will merely transmit the data to ground control.

At ground control: 'Was there ever life on Mars? *Rover* can tell us soon. She has her samples.'

'*Rover* is the only life on Mars.'

'We'll see. Open my briefcase.'

'Champagne?'

'Warm California champagne. In seventeen minutes we'll know whether we can crack it open.'

'I'll get some ice.'

'Don't bother. The ice machine is on the blink.'

Eight signals, seven ants. One of Rover's ants is stranded somewhere on the Face, a formation *Rover* knows simply as a set of parameters that it is forbidden to travel within.

Rover proceeds toward the primary target, testing the samples and transmitting the test results to ground control as it goes—to ground control, to Earth, where they wait. ∞

Perpetual motion: Why do these machines come to a standstill?

GAMES

By Scot Morris

On July 31, 1790, the first U.S. patent was granted by President George Washington and Secretary of State Thomas Jefferson. Both men signed the document which recognized an improved process of making potash (a chemical compound), invented by Samuel Hopkins of Philadelphia.

On this two-hundredth anniversary we salute the spirit of inventors to whom nothing is impossible, those eternal optimists who feel personally challenged when others say, "It can't be done." One such pursuit considered fruitless is the search for a perpetual motion machine—one that, once set in motion, will continue with no additional energy required to maintain it. But by definition, such a machine violates the laws of thermodynamics.

The first law, known as the conservation of energy, states (as an axiom without proof) that energy cannot be created or destroyed, it can only be transformed into work or heat. You can't get something from nothing.

There is a loophole in the first law. Granted energy can't be created, but maybe it can be recaptured and used over and over. Perhaps the work and the heat can be converted back into energy to perform the work over again. This assumption lies behind designs of a battery that powers a motor that runs a generator that recharges the battery. Or a sealed box with a light bulb inside, surrounded by solar collectors, which power the bulb. Or a motor that boils water with heat from its own exhaust pipe. These are called perpetual motion machines of the second kind, because they violate the second law of thermodynamics (as distinct from the previous perpetual motion machines).

The second law says that heat can't be completely converted into work. Some energy is irrecoverable and escapes as waste heat. Just as water won't run uphill naturally, heat won't run uphill from a cold body to a hotter body. It goes only the other way.

The third law of thermodynamics says that the one way flow of heat never ends. The three laws have been succinctly summarized as 1) you can't win, 2) you can't break even, and 3) you can't get out of the game.

Most people know that perpetual motion is supposed to be impossible but can't always say what's wrong with a particular scheme. Here are some classic candidates for the chimera. Can you figure out what's wrong with them? (The answers to all seven problems will appear next month.)

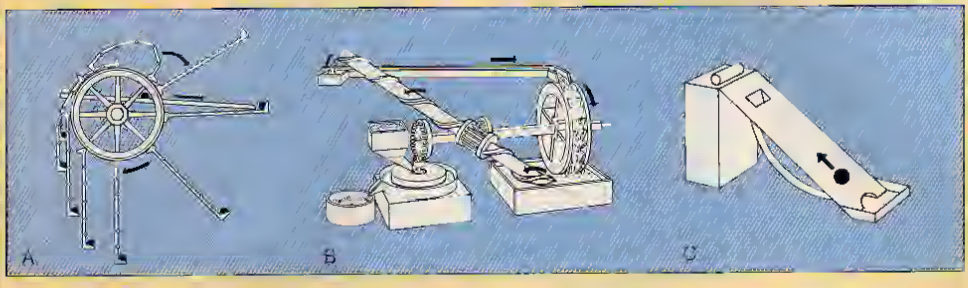
1. THE OVERBALANCED WHEEL. The most common proposal is a wheel that turns forever because it is always heavier on one side than the other. In a typical example, steel balls roll along tracks in curved spokes so that they are near the rim of the wheel on the right side, forcing that side downward, then they roll back closer to the hub on the ascending side. The wheel is supposed to keep turning clockwise forever. In another version (figure A, shown at right), weighted arms are fully extended on the downswing but hang limp on the other side. These schemes look good on paper—so good that hundreds of variations on this plan have been proposed and some even patented. What is the fatal flaw in them all?

2. SELF-PROPELLED WATERWHEEL. Millers who used waterwheels often wondered whether it would be possible to collect water from the race at the bottom of the wheel and somehow put it back into the reservoir above to be used over again, thus eliminating the need for a source of running water. One way to make water go uphill is to use Archimedes' invention of a screw in a tube. Dip one end of the tube in water, turn the screw, and water rises. In 1618 English physician Robert Fludd proposed the plan shown at right (figure B). A waterwheel turns an Archimedes' screw to pump the water back up and into the wheel again, recycling the water supply indefinitely. Why won't the machine work?

3. MAGIC MAGNETS. There is something magical about the way a magnet attracts iron. Inventors have tried to find a way to interrupt the magnetism so that attractions could be repeated endlessly. In the simple machine proposed by the Bishop of Chester in the 1670's (figure C at right), a magnet at the top of the column pulls the iron ball up the ramp. The ball falls through the hole at the top, rolls back to the start, and is pulled up again. Will it work?

4. HEAT PUMP. In the Seventies and early Eighties, Stewart Energy Systems of Idaho raised millions in investments for an irrigation pump that worked without fuel. It was to get its power by extracting heat from water in a well. A simple calculation shows that a 3°F drop in one pound of water can release three British thermal units of heat energy, enough to lift that pound of water more than 2,300 feet in order to irrigate a field. The calculations are sound. But why isn't the pump in use today?

5. PERPETUAL CLOCK. Around 1760 James Cox built a clock powered by a giant barometer. A reservoir held 150 pounds of mercury, and an ingenious linkage turned the clock's winding wheel whenever the mercury level changed—either up or down, whether the mercury rose or fell. Arthur W.J.G. Ord-Hume reported in *Perpetual Motion: The History of an Obsession* that the clock worked



perfectly. Ord-Hume guessed that it would have continued running for a "few hundred years" had it not been dismantled and the expensive mercury removed more than a century ago. Cox, who called his timepiece The Perpetual Motion, was a man before his time. But his clock wouldn't qualify as a perpetual motion machine, even if it ran forever. Why not?

6. DUNKING DUCK. The toy at right (D) has been around for about 40 years. The bird's head is initially wet by dunking. Once it starts drying, the evaporation causes cooling, and the vapor inside condenses, causing a partial vacuum, which makes the red fluid (ethyl ether) rise in the tube from the tail bulb to the head. The bird becomes top-heavy and tips to "drink" from the glass, wetting its beak again. The tube in the tail rises above the liquid, breaking the vacuum, the fluid flows back down the tube into the tail section, and the bird rights itself again to repeat the cycle. As long as there is water in the glass, the action will continue indefinitely. Could a perpetual motion machine be built utilizing this principle?

7. THE SCHADEWALD GRAVITY ENGINE. The late physicist P.A.M. Dirac conjectured that the universal force of gravity is slowly decreasing. If this is true, consider a wheel with one heavy weight at the top. As the weight rotates to the bottom, the wheel picks up kinetic energy, which transfers back to potential energy as the weight swings up the other side. Since gravity is decreasing, the value of g is less on the second part of the revolution. From the formula $mg_1H > mg_2H$, it follows that there should be a net gain in kinetic energy, causing the wheel to speed up indefinitely with every revolution.

Science writer Robert Schadewald reported this breakthrough as his own in *Science Digest* in April 1978. He closed the article this way: "As of April 1, 1978, I yield my invention to the public domain, that it may solve the energy crisis and bring peace and prosperity to the world. I ask only that my initials be inscribed on the wheel of every engine, so that my genius may get the sort of recognition it deserves. —Bob Schadewald."

Despite such bold hints that this was an April Fools' joke, Schadewald was taken seriously. Some people wrote him and asked for more information, others sent drawings of their own machines, and one person even telephoned and offered to buy the plans. The physics and mathematics of the Schadewald Engine are valid. What's wrong with the machine?

As the U.S. patent office enters its third century and as patent number 5,000,000 approaches (the patent will probably be awarded early next year), we salute all inventors everywhere for their perpetual drive to create new and useful things. As a tribute to inventors' creativity, we will be running a pictorial in an upcoming issue featuring some of the more famous inventions patented in the United States. ☐☐

GAMES

Not long after Pong the first successful video game character, ricocheted across TV screens little video guys were slugging pitching, and fielding on electronic baseball diamonds And the great American pastime quickly became a touchstone for sports-related video games

The first baseball simulations put as much demand on the imagination as on the technology The players were primitive stick figures The playing fields were crudely geometric And the games delivered arcade action but overlooked any simulation of reality The latest baseball video games, however, have it all sports action, managing strategy and real player simulation

Jaleco's *Bases Loaded* is just one of several baseball games for the Nintendo Entertainment System (NES) that hit deep with action and simulation Check out the bullpens of teams from Boston to Washington DC and you'll find a stats-packed mix of fictional heavy hitters and flyswatters (Be sure to exploit the muscle of the *Bases Loaded* character known as Paste from Jersey) Once you're on the field *Bases Loaded* fills the roster with action features that include a choice of pitching options, batting styles base stealing, and fielding (Jaleco has also released *Bases Loaded II*)

Reggie Jackson Baseball brings visual glamour

to the Sega Master System In single-game exhibition or tournament play you can choose from 26 teams modeled on the stats of real-world ball clubs

Ball games on the more powerful 16-bit systems get even closer to broadcast quality Hudson Soft's *World Class Baseball* for the NEC TurboGrafx-16 not only provides more detailed graphics it can also provide video screen inset pictures to help you keep a pitcher's eye on the base-stealing runner or the position of the outfielders

On the Genesis system Sega s *Tommy Lasorda Baseball* boasts inset screens that display extra field views as well as player stats Pick up a quick one-game exhibition or opt for a 30-game season (The cartridge can save seasons in progress)

Computer owners can take their pick of baseball temptations from pure statistical simulation to joystick pummeling intensity Electronic Arts' *Earl Weaver Baseball* (IBM PC, Amiga, Apple II) goes for the pennant with split-screen visuals, full-season league play trading and drafting more than 50 fielding and hitting stats and more than 30 pitching stats plus statistics on Mickey Mantle and other historical players It re-creates the actual design and dimensions of several ball fields and takes such realities as weather and wind into account

Accolade's original *Hardball* was a great baseball action game with limited strategic elements *Hardball II* (IBM PC, Amiga) keeps the terrific play action, dresses up the graphics, improves the animation and enhances the simulation with more numbers, actually updating your players' performance for each at bat

If you're not into joysticks but love Strat-o-matic the paper-based statistics game take a swing at MicroLeague Sports Association's *MicroLeague's Baseball II*, one of the best statistical management simulations on the market Use one of the program's historical teams, or draft and trade your own lineup of the greatest players of all time Manage a game and print out a full box score with sports-page detail

Okay, sluggers All that's missing is for you to leap out of the dugout brandishing that Power Pad, joystick or keyboard —Bob Lindstrom

STAR TECH

ACCESSING THE FUTURE

MOW TOWN

The Lawn Ranger (above) is a self-propelled lawn mower that will clip your front yard by itself—thanks to its built-in computer and sensors. Cost: $690 for electronic kit. Contact: Technical Solutions, Onmascus, MD; (301) 253-4933.

BOUND FOR GLORY

The No Problem! (left) binds up to 30 pages in a neat, professional-looking package. Comes with prepunched paper, covers, and binding elements. Cost: $99.95. Contact: General Binding Corporation, Northbrook, IL; (900) 342-5422.

SHARPER IMAGE

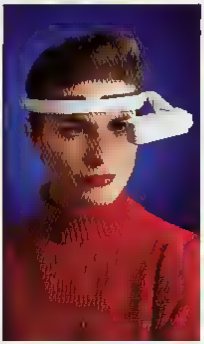
Catch the action with binoculars that are always in focus. Cost: $116. Contact: Jason Empire, Overland Park, KS; (913) 888-0220.

SAIL OF A NEW MACHINE

The Pionusail's (left) radical wing uses a sophisticated computer program to adjust automatically to wind speed and direction. Cost: about $400,000. Contact: Walker Wingsail Systems, Plymouth, Devon, UK; 011 44 752 605426.

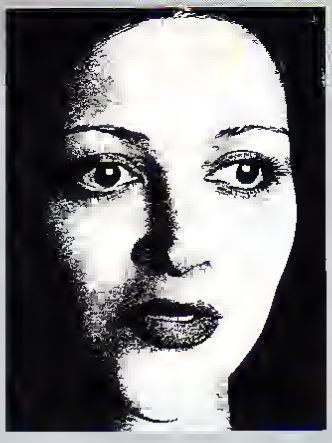
HEAD FOR FIGURES

The Reflection Technology Private Eye display (below) combined with the Ampra Little Board computer takes the lop out of portable computing. Cost: about $1,000. Contact: Ampra Computers, Sunnyvale, CA; (408) 734-2800.



ROAD CARRIER

The CarryOr (above) converts from two-wheel wagon to comfortable outdoor lounger. Weighs just 13 pounds. Cost: $89 to $149. Contact: Sealr Dynamics, Boca Beton, FL; (407) 338-7147.



LAST WORD

By Victoria Lacas

"He said that I would see him again, that I was "special" and "chosen." But don't they all say things like that? Sure enough, it's been three weeks and still there's no sign of him."

I first saw him in a parking lot outside a club. He came right up to my car out of nowhere and just stood there staring at me with those big, black hypnotic eyes for what seemed like an eternity. Then, wouldn't you know it, the car wouldn't start right away. The whole parking lot lit up. It started lightning and thundering. I was scared at first—of course no one was around. I could see lights behind me until I lost him when we hit traffic.

I couldn't stop thinking about him. It was so weird! I hadn't seen him in the club—you would have noticed this guy right away. He was short, but I figured, So what? And a week in Florida wouldn't have hurt him. The hair thing—the no-hair thing—was a radical departure for me, but all men lose their hair eventually, right? He had a determined, no-nonsense, authoritative way about him, which I kind of liked. And he was definitely new to the area.

I kept thinking, *How am I ever going to see him again?* I looked for him every time I went out. Did he think I had all the time in the world? I started fantasizing about him—what it would be like, what we would talk about. And dreaming about him! You know, those wacky dreams where nothing makes any sense and nothing's familiar but you fit right in?

Well, he found me (he probably has a friend who works for the Motor Vehicle Bureau). He picked me up (literally), and I live way out in the suburbs. He must have a good job because he had a bunch of people with him. I bet it's with the government—I mean, he was wearing a uniform.

It was real late. He must have come straight from work. He was in a real hurry, too, and not very subtle. He came right into my bedroom and whisked me away. There was a chauffeur-driven something or other waiting outside. Once inside the thing, we had a drink. Well, I did. It was really strong stuff and made me kind of dizzy and lightheaded. He took me to a very interesting place, but I was too dizzy to really enjoy myself. He practically had to carry me. I felt like I was floating!

He didn't talk about himself but asked me lots of questions. He seemed really interested. He just stared at me the whole time. I felt like he was reading my mind! He must have thought I was real smart because he asked me lots of questions about science, physics, and mathematics. I don't remember everything we talked about, but he asked me questions like, "What is time?" I mean, how do I know what time is? But I guess I impressed him because then he asked me lots of questions about religion.

Afterward we went to his room. The style was like, I don't know. Cosmic Zen—just a table with lots of gadgets set into the walls. He wasn't exactly the most romantic guy I'd ever been with. And I sure didn't like having all the lights on or his friends watching. His body, well, a body's not everything—this guy had a brain. If head size means anything, he's a genius. He really liked my body. They all did, in fact. Finally they left us alone.

It must have been an intense experience for him because then he gave me a little gift. It's probably really valuable where he comes from. He must have figured I'd lose it since he put it inside my head for safekeeping. Maybe it's like giving flowers here. Or maybe we're engaged. I mean, he started to get real serious, talking about settling down here and having children with me. This being our first date, I told him I'd have to give it some thought. After all, we come from very different backgrounds. Our parents would have to meet first. Would our friends be able to get along?

Before I knew it, I was home. And four hours had passed!

He said I'd see him again, that I was "special" and "chosen." I wasn't so sure I believed him. Don't they all say things like that afterward? Sure enough, it's been three weeks and still no sign of him. I knew I shouldn't have gone to his place on the first date. I guess it's the same rules all over.

I started hearing that he'd been seen upstate. I even went out late one night looking for him. I met a few ladies who were looking for him, too. They were really mad, saying he forced himself on them. They didn't look like the type of ladies who would make up stories. But they didn't look like they should be doing so much complaining either. (They probably have the wrong guy anyhow.) I tried to straighten them out, you know, how there's a shortage of eligible men with responsible jobs. "Hey, girls, wake up!" I said. "It's hand-to-hand combat out there." Why didn't they just cool out about it? If they'd be honest with themselves for a minute, didn't they have a really interesting time? They'd probably had a lot worse dates, right?

Somehow I left reassured. So what if I can't remember everything that happened? Was it just a one-night stand? Was he just another intergalactic playboy, playing the extraterrestrial field? I'm pretty sure I had a good time. Maybe our evening together—my big night of alien courtship—was a lifelong commitment for him. Like a 50-year marriage, you know?

Well, as I see it, there's only one major drawback—he travels a lot—but all things considered, a good "man" is hard to find. OO

Victoria Lacas has never seen a UFO, but she will date short, interesting men.