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CONTENTS

Future Vision is the creation of Kansas City photographer Michael Radencich. A quadruple exposure on one sheet of film simulates a computer-generated image. A window hangs in space and opens to a distant star cluster. Lightning flashes over a sprawling cityscape.

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FIRST WORD

By Gregory Benford

"The one positive thing you can say for nuclear weapons is that they have kept peace at the strategic level for 37 years"

...age is the child of an awful marriage the mating of the rocket and the atom The debate over President Reagan's defense budget demonstrates that there are many divergent opinions about strategic weapons and basically nobody likes this situation

Some try to blame the nuclear Armageddon problem on the munitions makers This confuses servants with masters Arms races are best understood as instabilities The most prudent response when you cannot know your enemy s intention is to prepare for the worst (It is comforting to realize that another disarmament cliche—that all arms races have ended with the full store of weaponry being used—is false as the history of chemical warfare shows)

The United States has been in an offensive weapons race since 1945 Games theorists would tell you that such races are inevitably fatal Eventually someone miscalculates and the greatest advantage then falls to him who strikes first and hardest

That's why an accidental launch can lead to an all-out war If a mad general manages to get off a few ICBMs an American or Soviet leader must swallow the obliteration of several cities or else respond in kind If he erases some enemy cities in the exchange then peace can be achieved only if both sides step back simultaneously Knowing this the side from which the accidental launch came might very well say ' Okay, the smartest move is Empty the holes!'

Civilization can t survive indefinitely with the inherent instability of offensive arms races. The usual reply to this fact is to advocate colossal concessions at disarmament talks The reasoning here is that somebody s got to take the risk of deescalating and we might as well be the ones because the West has always been more flexible

The trouble is rapid disarmament is loaded with destabilizing scenarios, too. The one positive thing you can say for nuclear weapons is that overall they have maintained peace at the strategic level for 37 years—the longest unbroken strategic peace in several centuries With nuclear superiority the West has stood off the USSR in Europe Cuba, and elsewhere without fielding massive Soviet-style armies and weaponry

We cannot contemplate rapid disarmament because it could cost us our trump cards, leading to war in the pursuit of peace.

The current superpower shouting match over arms reduction assumes that fewer warheads means greater safety This is not so. Once there were only two bombs in the world. Both were dropped

Post–World War II rhetoric has concentrated on two unsatisfactory choices an offensive arms race versus No Nukes oversimplifications Is there another choice a third escape hatch?

...ies a defensive instinct

Nobody in the Reagan Administration likes the word *defensive* very much It calls to mind those anti-ICBMs of the Sixties which exploded hydrogen warheads over the United States to destroy incoming Soviet missiles A messy, dangerous ' defense

In the Eighties though we can defend ourselves in space Stations in orbit can fire projectiles at rising boosters damaging them so badly that the rockets tumble out of contro These projectiles can even hit warheads that have already dropped their boosters and begun the long coasting orbit to reentry This coasting phase may last ten minutes creating lots of time for sharpshooting that can penetrate the hardened steel warheads and kill the detonation devices

This isn t pipe dream technology It's a real possibility. The projectiles might be beams of ions and electrons ("Zeus in Orbit " September 1981) Though a better bet might be electromagnetic guns These devices accelerate steel-jacketed slugs to enormous velocities— three kilometers per second or even faster The U S Navy has developed certain types called rail guns, for shooting at fast-approaching cruise missiles A one-ounce slug moving at that speed can do enormous damage to boosters or warheads Firing at rates of ten per second, a battle station can get in hundreds of shots at rising boosters and thousands of tries at coasting warheads

It is quite possible that we could change the entire strategic momentum by committing ourselves to a solely defensive arms race With a projectile station swarm overhead we can prevent accidents from escalating into suicide If the United States stays ahead of the USSR while both sides deploy these stations into orbit things will become more stable as we complete our system

Thereafter no other nuclear power will have any ICBM-type strategic presence unless it builds a projectile weapons system Unlike offensive systems the addition of a new projectile-station system makes the situation more stable

Battle stations in orbit cannot penetrate the atmosphere with their slugs so they can't be used offensively against any nation At worst, they can destroy other satellites but we already live with anti-satellite weapons and so that doesn't alter the picture

It is time to quit deploring all arms races We should distinguish between suicidal offensive systems and shrewd defensive ones True they all cost money True mankind would be wiser to negotiate a way out But 37 years has not given us any idea of how to do that. Humankind will continue to arm if history is any guide Let s do it intelligently

Gregory Benford is a professor of physics at the University of California at Irvine

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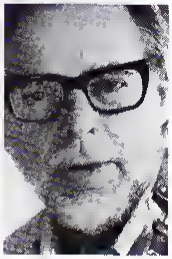
HARRINGTON


SIMMONS


ONOSKO


SWANWICK

If you believe the Wright brothers designed the first airplane, that plastic is a twentieth-century invention, and that brain surgery is a skill known only to modern medicine, *Robert Patton*'s article on out-of-place artifacts, or "ooparts," may make you think again. Patton is an antiquarian by hobby and a free-lance health and science writer by profession. His work has appeared in such diverse publications as the *Village Voice*, *Cosmopolitan*, and *Objectif 2000*, a Swiss encyclopedia. Starting on page 52, Patton highlights myriad historical anomalies that, in his own words, "are certain to challenge the conviction of those who believe our knowledge of the past is complete."

"I wanted to find out more about the ideas behind this one-billion-dollar dream park," says *Tim Onosko*, who traveled to Glendale, California, to look at the plans for EPCOT—Walt Disney's Experimental Prototype Community of Tomorrow. It is part classroom, part world's fair, and part amusement park, and it opens next month in Orlando, Florida. WED (for Walter Elias Disney) Enterprises is the entertainment think tank that designed and built EPCOT 15 years after Disney died. It was his associates' answer to the problem of how to use all that Florida real estate he left behind. "EPCOT is going to be a rich field for Disney watchers to mine," Onosko says. "I think Disney's critics will have as much fun with the place as his fans will. For a behind-the-scenes look at "Tomorrow Lands," turn to page 68.

In this month's Interview (page 94), physicist Hans Bethe explains why we should love nuclear power plants. He reminisces about the good old days at Los Alamos, where he held a key position on the wartime Manhattan Project, and simultaneously looks forward to the future of fusion energy. Recent decades have seen him advising U.S. presidents while working to limit nuclear arms. For the interviewer, physicist *T. A. Heppenheimer*, this subject is all in the family. During the Forties his mother was secretary to one of the Manhattan Project's leading mathematicians, Heppenheimer, who is the author of *Colonies in Space* and an upcoming book on fusion power, shares much in common with Bethe. "We're both of German descent," he notes. "We've both held positions at the California Institute of Technology. We're both listed in *Who's Who in the World*. However, only Dr. Bethe has won the Nobel Prize."

"Computer chips are sexy," says photomicrographer *Phillip Harrington*, who sought refuge in this Lilliputian world mainly as a diversion from his career as a photojournalist for *Look* magazine. After far-ranging trips on assignments abroad, Harrington would come home to New York and relax by peering into a microscope and shooting the essence of the small things he saw there. It wasn't long before he became lost in his electronic labyrinths, and what began as an avocation turned into a full-time profession. His unique photographs of computer chips (see page 76) provide an insider's view of what goes on at the heart of your pocket calculator, video game, telephone, and friendly neighborhood supermarket scanner.

Two science-fiction writers make their debut in *Omni* this month. *Michael Swanwick*, who was nominated for a Nebula Award earlier this year, and *Dan Simmons*, a recent winner of the Twilight Zone Magazine Short Story Contest. An encounter with a giant of the modern-art movement is the subject of Swanwick's charming tale "The Man Who Met Picasso" (page 60). And telepathy proves to be a blessing for a blind and deaf child in Simmons's moving story "Eyes I Dare Not Meet in Dreams" (page 82). "The theme developed from a summer I spent working with handicapped and retarded children," says Simmons, who teaches normal sixth graders when he's not writing. "The heroism I witnessed there has stayed with me."

Television update: Women in Communications, the nationwide professional organization for men and women in the media, has given the television series *Omni: The New Frontier* a Clarion Award for excellence in the Local Television Documentary Series Category, the "World We Live In" Division. Watch for announcements of upcoming episodes in your local TV listings. OQ

LETTERS

COMMUNICATIONS

Great Scot!

Omni's brief article on the late Comyns Beaumont and his as-yet-unpublished manuscript "The Constantine Conspiracy ["The Jerusalem Cover-Up," Antimatter, May 1982] was a welcome change from the unwarranted neglect that has characterized this pioneering British catastrophist.

There was, however, one particular misstatement in the article that should be corrected. It was reported that "for political reasons, Constantine the Great had the Hebrew scribe Ezra rewrite the Bible to cover up the move from Edinburgh to the Middle East."

Constantine may have been called the Great, but neither Comyns Beaumont nor I have ever maintained that he was great enough to recall Ezra from his grave approximately 1,000 years after he died and order him to rewrite the Bible. That would have required a Greater Authority.

Robert Stephanos
Philadelphia

As a native son and longtime resident of Edinburgh, Scotland, I was most delighted to find that, at last, someone had recognized the divine qualities of the aforementioned city. However, as I read more carefully, I discovered that the amazing parallels between Edinburgh and the biblical description of Jerusalem were, at best, contrived.

Try as I might, I can think of no main street that "twists like a boa constrictor." The obvious candidates for the designation "main street" are Princes Street and the Royal Mile/Canongate. While they differ in antiquity, it is inconceivable that either existed in biblical times, and furthermore, both could have been drawn with a passable ruler.

As to Arthur's Seat, three peaks there may be, but the whole extinct volcano is situated to the *east* of the town and never had a castle resting thereupon.

Lastly, although Joppa certainly sounds appealingly like Jaffa, it does not qualify as Edinburgh's port.

Ken Turnbull
Dayton, Ohio

In the Eye of the Beholder

After viewing the photograph of model-photographer Lucille Khornak in the May issue of *Omni*, I was reassured that there are still beautiful women in the world. I then went on to look at her photographs, and I was dismayed to learn that beauty in women's fashions is headed for extinction.

Harold Freiman
Saratoga, Calif.

Thank you for the wonderfully unimpressive, prosaic, and soporific pictorial on future trends in "Fashion 2001." It staggers the imagination to think what we'll be wearing in 2002.

Peter Tinebra
Wichita, Kan.

I found "Future Fashion" to be totally laughable. I foresee the eventual extinction of fashion designers, who are interested only in making a fast buck.

This will leave people free to design their own clothing that will accentuate their individuality.

Susan Morris
Calgary, Alta., Canada

Skeptical Investigations

I was a bit surprised to see James Randi [Last Word, May 1982] list me as a nominee for his Uri awards because I "visited China to investigate children there who claimed to be able to read writing on a slip of paper by sitting on it or stuffing it in one ear."

Since I went to China a skeptic and returned with my doubts reinforced, I can only presume that Randi now opposes investigation into the claims of the paranormal, which he seeks to debunk. True skepticism means having doubts but encouraging open-minded inquiry.

Marcello Truzzi
Ypsilanti, Mich.

Skeptical Inquiry

The article entitled "Therapy by Mail" [Mind, April 1982] caught my eye immediately. Being a born skeptic, however, I have several doubts in my mind.

CONTINUED ON PAGE 119

FORUM

In which the readers, editors, and correspondents discuss theories and speculation arising out of Omni. Readers are encouraged to debate views and pose questions to Omni, the scientific community, and the science-fiction establishment. The opinions published are not necessarily those of the editors.

Unnecessary Nutrition

I was disappointed with the article "Dr C's Vitamin Elixirs," by Kathleen Stein [April 1982]. Michael Colgan's educational background does not seem to indicate that he is an expert in nutritional science.

I find it odd that he is quoted as saying, "Overdosing is the most common mistake," yet he lists megadoses of many vitamins in his daily formula.

No valid scientific literature has been published demonstrating that a healthy, nonpregnant person, eating a well-balanced diet, needs a vitamin supplement.

Betty Redfern
Berkley, Mich.

Dr. Michael Colgan replies: *My forthcoming book for those uninformed about vitamins and minerals, Your Personal Vitamin Profile (William Morrow and Co., Inc.), lists approximately 2,000 papers in medical and other scientific journals that give evidence of effects vitamin and mineral supplements have in preventing and ameliorating the major degenerative diseases.*

The formula given in the article does not list so-called mega qualities. There is a common misapprehension that the Recommended Daily Allowances (RDAs) represent appropriate amounts of nutrients. The RDAs do not provide the amounts of nutrients required for optimum health, but merely the amounts required to prevent certain deficiency diseases.

Peaceful Majority

The British gentleman who chided the Moral Majority in Communications [April 1982] frightens me almost as much as the Moral Majority seems to frighten him. His insidious vision of America leading this planet toward the exploitation of outer space ranks among the most anthropocentric notions conceivable.

While the Moral Majority would impose its ideology only on a nation, he would propagate a species capable of annihilating all life forms on a planet with a single blow.

Gordon Wetzel
Brentwood, Calif.

Musical Notes

It's great to see *Omni* devoting space to developments in digital sound synthesis ["Silicon Orchestras," April 1982]. All of us who are involved in electronic music are excited by the far-reaching capabilities of these new instruments and the extraordinary music that can be played on them. Unfortunately, your article did not give a balanced, truly informative account of the advances in this field.

Having seen and played the General Development System, I can testify that it is indeed a marvelous instrument. But by no stretch of the imagination is it "generally considered to be the Rolls-Royce of synthesizers."

If "Silicon Orchestras" had been a real attempt to let readers know what is going on in the field, Spider Robinson would have mentioned other synthesizers such as the Synclavier or the Computer Musical Instrument. Microcomputers are currently being used as the building blocks of a new generation of low-priced digital synthesizers.

It would have been nice if your article had mentioned other developments in this rapidly growing field.

Jim Aikin
Cupertino, Calif.

Space Co-op

The space program I have been so proud of for so long is slowly being throttled by economic red tape. Exploring space is extremely expensive. Yet there are many more "immediate" problems facing our nation today that demand to be funded.

There is a solution to this problem. Perhaps we could form a sort of "cooperative" among allied nations. It wouldn't be the first time that many nations pitched in for the benefit of all. This is bigger than petty politics. This is the future of the world.

C. J. Harper
Albuquerque, N.M.

Chemotherapy

In the article "Carotene for Cancer" [Continuum, May 1982], Richard Levine writes, "Cancer patients treated with chemotherapy are debilitated by nausea and vomiting. Their hair falls out, they lose weight."

I am surprised and exfremely annoyed that a magazine of your caliber would print such an erroneous generalization. Not all chemotherapy patients are afflicted with these symptoms. This statement only reaffirms the public's misunderstanding and fear of chemotherapy.

Roger Clark
Kanab, Utah

Speaking Clearly

As a practicing speech pathologist who provides therapy for many laryngectomized patients, I must take issue with Phoebe Hoban's article "Voice Button" [Continuum, May 1982].

Although Dr. William Panje's procedure has been successful in restoring voice to many laryngectomees, it is not a procedure that can be routinely done on every patient. Consequently, there are many laryngectomees who must rely on devices such as the electrolarynx for them to communicate. To these persons, such devices are not "unattractive" and do not produce a "robotlike sound." They can mean the difference between a life of isolation and one of socialization.

Merle Irvin
San Diego, Calif.

Feasible Fusion

Edward Kinter [First Word, May 1982] expressed his concern about the fact that we are losing our lead in the area of fusion technology. In particular, Kinter wondered why the Reagan Administra-

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COLLIDING CONTINENTS

EARTH

By Marcia F Bartuslak

The time is 50 million years from now For millennia Australia has drifted northward at the astounding speed' of three inches a year to end up nestled against Southeast Asia That 3,000-mile trip from the southern reaches of the Pacific Ocean into warmer equatorial waters has turned the bleak dry interior of the giant island continent into a tropical paradise Kangaroos and koala bears (or whatever new fauna they have evolved into) can finally venture into a new continental neighborhood ending a geographical isolation that has lasted millions of years

The very idea that continents like Australia might move about the globe was considered ludicrous as late as the 1950s But today because of the work of dozens of geologists such as Alfred Ziegler and Christopher Scotese of the University of Chicago the theory of a mobile terra firma has been accepted as fact By studying the dozen or so plates forming the earth's outer crust Ziegler and Scotese have traced the movement of the continents as far back as half a billion years And now with the help of a computer they have reversed the arrow of time By analyzing present day plate movements the Chicago group has managed to project the earth s wrenchings tearings and crunchings into the future

According to Ziegler future geography will be forged by the same geological rules that have shaped the earth for eons Propelled by the turbulent motion of the earth s scorching inner core some plates will collide thrusting mountain ranges upward opening trenches wide, and rumbling the plains Other plates will move apart, spewing molten material to form volcanoes and new seafloors And although scientists don t yet understand exactly why, immense continental slabs like Australia will continue to raft inexorably north as they have done for billions of years

Southwest California, for instance is tearing loose from the mainland along the infamous San Andreas Fault and traveling northward on the Pacific plate at about four inches a year Within 10 million years Angelenos will be able to pick up the hearts they left in San Francisco as their city glides right by the Bay Area In another 50 million years that nomadic piece of California will probably plaster itself onto Alaska

Africa is also going with the flow as it inches northward toward Europe After the two continents clash some 50 million years hence the Mediterranean Sea may disappear and in its place may rise a string of mountains to rival some of the highest in the world In fact with the Australian plate slamming into Asia at just the same time it s not unlikely that a Himalayan-type chain will run halfway around the globe—starting at Spain and stretching eastward for thousands of miles to the South China Sea

With Australia bumping into Asia, and Africa colliding with Europe it s inevitable that other immense slabs will be moving apart giving molten magma from deep within the earth the chance to rise and form a huge ocean floor The Red Sea is such an ocean in the making Indeed if the Saudi Arabian peninsula continues moving away from Africa at the same rate as today the embryonic Red Sea could be as wide as the Atlantic Ocean in about 200 million years

A shallow sea may one day cover the earth

No matter what the change, Ziegler notes geographical refurbishing is going to play havoc with present-day climatic patterns And with each shift in weather local flora and fauna will either die out mutate or adapt As Africa moves northward the Sahara will probably bloom, while the thick Congo jungle in the very heart of the continent withers away On the other side of the world northwest Canada might sprout oranges and palms as the North American plate rotates left

But ultimately the dance of the continents will end The earth s interior engine—its molten core—will cool And like a rundown carousel, plate movement will first become sluggish and then in a few billion years, stop altogether

It s going to be a sad time for Earth says Scotese Without the power to keep peaks uplifted the mountains will easily erode Relentless rains and whirling winds will soon flatten the entire surface of the earth "Erosional processes would probably get the Himalayas down to Appalachian size in just thirty million to forty million years Scotese says a mere blink in geologic time

In such a world evolution will lose its impetus Scotese explains "The movements of the plates are always throwing down the evolutionary gauntlet, so to speak to plants and animals 'Here s a new mountain range you have to get through,' it says Or We re going to rip this continent in half so you ll have to evolve into two different species now Once the continents stop moving there will be no such challenge

According to one scenario the continents may die out completely Not the meek but the aquatic will inherit the earth as one shallow sea eventually covers the flattened terrain with only a few islands dotting the monotonous seascape where the highest mountains had been located As Scotese remarks "I guess only the fish will like it a lot DO

THE MASTER CODE

LIFE

By Dr. Bernard Dixon

Imagine you could travel through time to select for study just one animal or plant that once lived on Earth. Which one would you choose? A Neanderthal man, plucked from his cave in Europe 100,000 years ago? One of those flightless birds, the dodoes, exterminated by early settlers in Mauritius three centuries back? *Calamites*, the mighty horsetail plant that gave us our coal?

There are plenty of fascinating possibilities—far too many when we think of all the species man himself has doomed to extinction or allowed to disappear through neglect. But if we explore the full range of options, most of us would choose one evolutionary pinnacle over all others: an encounter with the primeval organism that spawned the rich diversity of life on this planet. What if we could travel backward along the path of evolution and return to visit our earliest, simplest ancestor?

Fantasy? Perhaps not. Maybe we are wrong to assume that this ancient one-celled creature must long since have vanished. Maybe the seeds of terrestrial life *have* continued to exist throughout millions of years of cataclysmic change.

This sensational proposition has been bolstered by three recent findings. First, scientists discovered a promising candidate—a microbe with the most primitive features ever detected in a living organism. Second, an independent group of researchers used theoretical calculations to determine the genetic code of the earth's oldest life form. Third, the newly uncovered microorganism proved to have a genetic message virtually identical to what the theorists had predicted.

The practice of charting evolution by comparing molecules, rather than visible structures, has grown enormously over the past two decades. We can now draw evolutionary trees, for example, by contrasting the detailed maps of proteins doing the same job in different plants and animals. The closer the molecular match, the more closely related are the species or subspecies concerned.

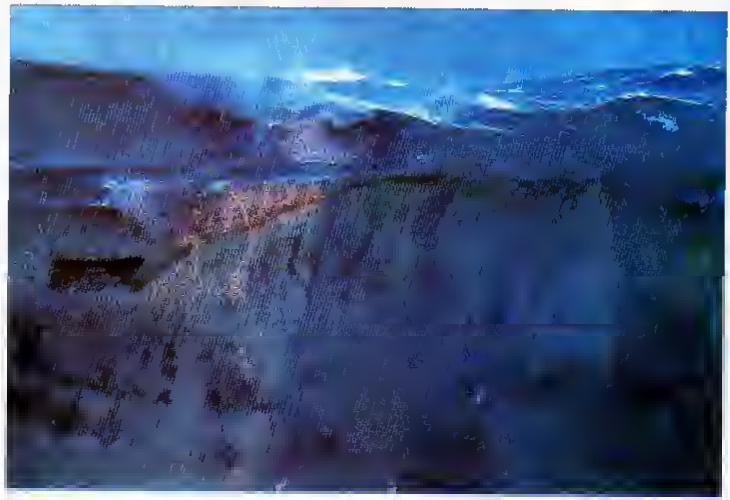
It took the genius of Professor Manfred Eigen, at the Gottingen Academy of Sciences in West Germany, to see that protein analysis could be augmented by an even more refined approach. Eigen probed the past by scrutinizing the hereditary material of a wide variety of living organisms. Using cryptographic techniques, the scientist was able to identify common sequences in the genetic code of diverse species. From the similarities that emerged, he could thus derive the master sequence—the primeval formula that gave rise to all subsequent genetic variation. This genetic sequence, he believes, may be the ancestral message carried by the first self-replicating entity to evolve on this planet.

Following the publication of this extraordinary piece of detective work in a technical journal last year, microbiologists began to search for signs of the master sequence in nature. Microorganisms *thought* to be primitive were a tempting target. Now it turns out that one of them does indeed carry a genetic sequence uncannily like that forecast by Eigen. As Dennis Searcy reports in *Trends in Biochemical Sciences*, it is a bacterium called *Thermoplasma acidophilum*—the name reflecting its bizarre preference for very hot, highly acidic conditions.

Thomas Brock, a professor at Indiana University in Bloomington, first isolated *Thermoplasma* from a pile of low-grade coal and metal sulfides at an abandoned coal mine in Indiana. Bacteria can survive inside such refuse heaps by oxidizing sulfides to sulfuric acid, generating excess heat and making the pile hot. Something very similar to *Thermoplasma* has also now been identified in a hot spring in Japan.

But could this strange organism have remained virtually unchanged since life began? It is certainly primitive—far more so than *Escherichia coli*, the well-known, lowly bowel bacterium. Its energy metabolism is extremely inefficient. And it does not even possess a cell wall.

A derelict coal mine in Indiana may seem to be an unlikely place to find what could prove to be our ultimate ancestor. Whatever the truth may be, that mine certainly harbors one of the most exotic creatures ever known. ∞



An abandoned coal mine harbors what some experts think may be our earliest ancestor

FRONTIER TOWN

SPACE

By Alcestis R. Oberg

Emerging slowly from a deep sleep, a welder finds himself floating momentarily lost in a womblike bedroom only seven feet long and four feet high and wide. Then he notices the small computer display on one wall, now projecting a picture of Earth as if drifts below the space station. On the opposite wall, transparent plastic pouches hold his few possessions.

His mind leaps forward a few minutes, anticipating a call to his family on Earth. It is a costly luxury, but one that gives him the comforting illusion that he is still part of their daily lives, even though he orbits 225 miles above the surface for six months of the year.

This could be a common scene in 20 years, for many space workers will share the welder's sense of being cut off from all that is familiar. "Disorientation in zero gravity and isolation are the two greatest challenges to the space architect," says Guillermo Trotti, a Houston architect who has helped to design *Spacehab*, the first small town in orbit.

Larger and more comfortable than the proposed Space Operations Center, which could be built by the late 1980s, *Spacehab* would be far less ambitious than the space cities designed by Princeton's Gerard O'Neill to hold 10,000. It was designed by University of Houston researchers during a three-year private study, one of the first detailed attempts by architects to cope with the strange environment of space. Guiding the effort were Larry Bell, director of the College of Architecture's Environmental Center, and Clinton Rappole, associate dean of the Hilton College of Hotel and Restaurant Management.

The 200-foot-long *Spacehab* is intended to support research and industry in space. Materials processing, drug manufacture, microgravity metallurgy, and crystal fabrication could all benefit from its facilities. So would Earth observation and even genetic engineering. "Special satellites too fragile to assemble and launch from Earth can be built and launched from *Spacehab*," Bell says.

At least a fifth of *Spacehab*'s 150 residents would be support personnel—the command crew, medical staff, galley workers, and the like. The rest would be scientists, industry technicians, satellite assembly workers, and such visitors as journalists, artists, poets, and researchers. To get the most out of the station, they would work on three eight-hour shifts.

Keeping people comfortable in their alien surroundings was the architects' greatest concern. An orbiting outpost, *Spacehab* would be the high frontier's version of the small towns that grew up in the American West a century ago. To avoid the stress that made Dodge City gunfights famous, the designers worked hard to shape human spaces that would seem familiar to earthlings yet still use the three-dimensional freedom of zero gravity to its greatest advantage.

Very unconventional construction made the job even more difficult. To pack the most living space into easily transported components, the architects decreed that *Spacehab*'s crew must live in balloons—eight mushroom-shaped, inflatable pods clustered around two cylindrical "core modules" assembled on Earth. It would take ten shuttle missions to move the parts into space. The core modules would contain all the electronics, life-support systems, propulsion, communications equipment, and command stations needed to sustain a small construction crew while the huge solar arrays and "habitation pods" were being deployed.

The living quarters would be built with a triple layer of pneumatic walls, the innermost of which would be woven of Kevlar 49, a light, flexible Dacron-like fabric as thin as a sheet of paper yet stronger than steel. A middle layer would provide insulation, and the exterior wall would be laminated with aluminum. The major inner walls would fold accordion-like, and the Kevlar could be reefed like a parachute to open slowly during inflation.

The 80-foot-diameter pods meet two major criteria—they minimize leakage of air and maximize useful volume—but Trotti notes that "they will have to be space-tested first, perhaps as spacecraft hangars, before we know for sure how

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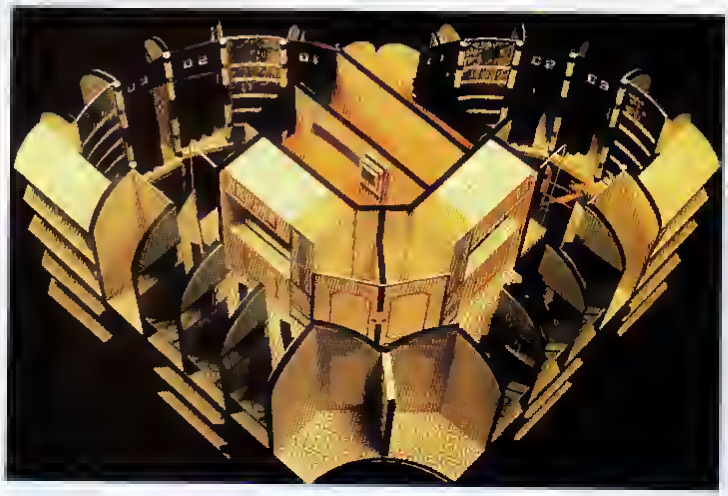

In this Spacehab section, bedrooms surround core area containing toilets and vending machines.

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MIND

By David Loye

For a long time we ordinary mortals have been awed by seers prophets oracles—and now computers—predicting the future This gift we have assumed is restricted to a chosen few or to the electronic wizardry of ENIAC the first computer and its many successors

Recent brain and mind research reveals that this is not the case Each of us possesses the gift of prophecy It is as fundamental to our well being as our ability to breathe is and we use it almost as regularly There is also good reason to suspect that it can be improved with methods based on a new understanding of how the brain and mind work

It was the great Russian neuropsychologist Alexander Luria who first discovered where in the brain this ability is located Working with brain-damaged patients he documented how our frontal brain is involved in actively seeking, selecting, and consolidating information that allows us to make forecasts

In one remarkable case Luria followed the tortured life of a brilliant young scientist named Zasetsky for 25 years Zasetsky had had part of his brain destroyed because of a head injury he'd suffered during World War II The injury was to the left rear portion of his brain and as a result he could not remember large parts of his past could barely talk and had even lost the ability to carry out simple actions Threading a needle for example was beyond him But through an agonizing process of rehabilitation he taught himself to write down his thoughts Luria could see that the man was still capable of other mental activities as well

Zasetsky understood what kind of brain damage he had suffered and more important, was able to see how it affected his future By comparison Luria noted that while frontally brain-damaged patients could perform tasks of speaking writing and drawing that Zasetsky found difficult or impossible they were baffled by one particular task They could not do anything that involved planning future actions When given tests frontally damaged people could not handle any problems that required them to think ahead rather than merely to use memorized facts

Another area of brain science that has provided insights into future thinking is the well-known research by Nobel laureate Roger Sperry and others into the differences between the left and right halves of the brain Stereotypically our left brain "rationally" chops reality into units of time allowing us to separate experiences into past present and future our right brain "intuitively" detects patterns of meaning that through our sense of space, provide another way of reading the shape of the future

Two other notable studies were done earlier during the 1930s The first was at MIT where psychologist Douglas McGregor polled 400 students for their opinions on the likelihood of nine future events When he compared the predictions to the events two years later he reported with some wonderment that the majority opinion of his group was 100 percent correct on every prediction Shortly after McGregor's work was published, Princeton University psychologist Hadley Cantril did a similar study, asking more than 200 people in a wide range of occupations for their predictions of events as distant as 50 years in the future

In the mid-1970s I came across these forgotten works and it occurred to me that since 40 years had passed since Cantril's study, it might be interesting to see how many of the majority's predictions had come true I found that of 14 ratable events or trends Cantril's people had correctly forecast 11 an accuracy of 79 percent This included the amazingly detailed prediction—in 1936—that another general European war would erupt in Central Europe and pit Germany Italy and Japan against France Great Britain the United States the USSR and Poland It would conclude within three to five years with the defeat of what came to be called the Axis powers

Building upon this earlier work I have concentrated in part, in my own research on developing a general model of right- left- and frontal-brain interaction

CONTINUED ON PAGE 134

Soothsayers beware There is new evidence we all have the gift of prophecy in our brain

MEDSPEAK

THE BODY

By Mary Carpenter

It didn't sound good, thought my friend Judy. All those tests had confirmed her fears. Something was terribly wrong. She had, her internist told her, "benign lymphatic hypertrophy." Worse, there was nothing to be done about it.

If wasn't until Judy was well on her way home that she realized what her doctor's ominous diagnosis really meant. She had swollen glands.

Whether or not they use obscure technical lingo, few doctors seem willing to talk clearly or with much understanding of their patients' feelings. And many patients, made vulnerable by their fear of illness and their dependence on this cold "expert," can be so completely undone by a doctor who neither speaks nor listens caringly that they neglect to supply essential information.

"Hmmm. This feels very strange to me," my gynecologist said, probing around rather roughly. Several minutes later, scowling ominously, she added, "I'm quite concerned. I can't tell what I'm feeling, but I think we should do some tests." A long, fearful week later, I returned only to find that the tests showed nothing and indeed, she said, my abdomen no longer felt abnormal. As an afterthought, she asked whether perchance I had been constipated last week.

Why do doctors have such trouble communicating? And does this problem interfere with diagnosis and treatment? To see how deeply doctors are affected by their medicalese, Wharton Business School professor J. Scott Armstrong invented a clever trap, using medical mumbo jumbo.

Slowly approaching the podium, "Dr. Fox" gazes haughtily over his dark tortoise-shell frames at a select group of distinguished psychiatrists, psychologists, teachers and administrators before delivering the third rendition of his lecture on "Mathematical Game Theory Applied to Physical Education." It is not an easy topic to understand, but every audience deemed the lecture clear and stimulating. Yet Dr. Fox is a fraud; his lecture is incomprehensible and the subject is deliberately nonsensical.

The idea that doctors are insensitive to patients may arise from their unfeeling language

Why should supposedly competent professionals be so gullible? When someone believed to be an authority speaks nonsense, Armstrong explains, the audience is caught in a conflict. To justify the time spent, those listening are forced to judge the talk stimulating, though over their heads.

But does this mean that the more unintelligible something is, the greater the need to rationalize? Armstrong thinks so. Testing reactions to passages of text with similar content, he found that the harder the research was to understand, the more competent it was rated.

People in general seem fairly clearheaded: if something is nonsense, there is a good chance that they will notice. It must take something very compelling to turn intelligent medical students into Dr. Fox's audience.

Ann Hudson Jones, assistant professor of literature and medicine at the University of Texas at Galveston, points out that medical-school writing tests show a steady descent from "clear, lucid prose to Germanically phrased, imponderable sentences." From the first day of school, learning the jargon becomes a rite of passage to inclusion in an elite that locks out the uninitiated by keeping them from understanding the profession's inner secrets. And then the technological lingo becomes addictive, requiring ever larger and more frequent fixes. A simple phrase like "swollen glands" just won't do.

After a long career of investigating glandular disorders, Dr. Nicholas Christy, chief of staff at the Brooklyn Veterans Administration Medical Center, has turned to the disease he calls Medspeak. He rejects the traditional excuses for medical jargon. It does not, he says, offer needed shortcuts for busy scientific minds; it doesn't even add much sense of urgency on slow days. Instead, he says, doctors must cut their explanations short only because it takes so long to disgorge words like *symptomatology* and *armamentarium*.

What this rhetoric really does, Dr.

CONTINUED ON PAGE 130

THE ARTS

By Diana Goodwin

The future of sculpture is not a subject high on the agenda of those people who devote their talents to this most dimensional of plastic arts. Sculptors routinely talk about exhibits, methods, technical processes, and other sculptors' works. They frequently theorize about historical trends, but rarely do they even glance forward to the state of their field as it may be in 50 or 100 years. The sculptors interviewed here are all able to speak volubly of formative influences and of their current work. But when the discussion arrived at the phrase *in the future*, there was initial anxiety evidenced by low whistles, lip-biting, shifting of feet, and the lighting of cigarettes to gain time. Marisol's characteristically economic "I live from day to day, I never think about the future" was representative of their common starting point.

The truth is, the future has as much relevance to sculptors as apples do to the moon. Artists, in their practice and by their natures, react rather than predict. As a group, they tend to behave like a sensitive membrane that vibrates feelings, mythologies, and observations back to the world. Within this context, the artists we spotlight here responded in person, on the phone, or in writing to questions concerning the direction that sculpture might take: the materials of the future and the effects these materials might have on sculptural concepts, and the status of sculpture in decades far ahead. As the first phase of perplexity passed, they willingly entertained these issues with imagination and poetry.

● **Richard Serra** has worked with a variety of materials and concepts, although he is best recognized for his large outdoor pieces in metal—usually Cor-Ten steel. "Sculpture will grow away from the traditional forms of stone and bronze," he says. "Those materials will be considered revisionist and reactionary. Advanced technology will serve the artist as an extension of the hand or nervous system. Materials will be developed that work well in non-gravitational situations, and, I suppose, there will be heavier gravity materials for various heavier gravity spaces.

The way art is now disseminated—through museums and galleries with their nineteenth-century elitist shopkeeper mentality—art is not allowed that doesn't fit into the clean white cubes. I hope in the future that freer spaces will allow sculpture to step out of this lobotomized, catatonic situation and have a more liberated identity."

● **Vito Acconci** is most noted for his conceptual pieces; he has recently begun making structures by using bicycles, clotheslines, jail cells, red flannel shirts, and other such unusual objects in strange new configurations. "In terms of a sculptor's materials—one future direction will be toward instant, portable microchip sculpture," he says. "There will be no reason for originals. Quality will be determined by the usefulness of a particular sculpture to a person in relation to his or her community. However, in reaction against this standard of smallness, of nonexistence, there will be a move in the direction of largeness, of monumentality—an attempt to build something like a worldwide stone.

There will be a breaking down of the distinct categories in art, and a constant widening of what's included as art. But as for museums and galleries—these are places with walls and painting, or the memory of painting—sculpture won't be in galleries. It will be outside in monuments akin to architecture and, in reaction to that, in bombs. I don't know whether I literally mean bombs, but for the radicals in art, bombs are a logical antithesis to monuments."

● **Edward Kienholz** creates environments and rooms, often using real furniture and fixtures that join "occupants" in one particular focus of the human condition. He tells *Omni*:

"Probably one phase of sculpture in the future will be a process in which the artist makes a prototype piece. It will be 'photoed' in holography and stored in a computer warehouse. Any museum or school could then apply to the warehouse through a cable-type system to reproduce the work, in light, in their

Duane Hanson: "One hundred years from now everyone will be getting tired of high tech art."

space or classroom. Only touch would be missing. As for materials, advanced polymers or plastics in new imitations of old materials should be in vogue."

• **Isaac Witkin** fabricates sculpture in metal, primarily bronze, pouring the molten metal into open-face molds and then joining the resulting shapes. "The new horizons in art will be no more important than anything done before," he says. "Just because an art form is new doesn't mean it's better. All the future can offer sculpture is an extended range in technical capabilities that promote new forms. If there is a significant revolution in sculpture in the coming decades, it will probably be a spatial one, in the same way that cubism was essentially a spatial revolution. Freeing sculpture from physical gravity, for example, might add new dimensions to the concept of form. 'Up' 'down,' 'side' and 'back' need no longer apply to our reading of objects. And color, instead of being applied to shape, may be frozen in space as shape itself. Immediacy of process might bring changes in attitude—a new direction replacing the slow, laborious way sculpture has traditionally been made.

"I doubt that the standards of excellence set by the ancients will ever be surpassed. Quality that lasts is decided by a consensus over a long period of time, and artists in the twenty-second century will be subject to the same judgments by which quality has always been determined."

• **Dennis Oppenheim** designs and constructs large "factories" using machinelike systems. He likens these structures to thought processes. He says, "There are beautiful mathematical theories that scientists give to determine the future, at least the future of physical laws. But sculpture right now is, quite frankly, dumb. It sits out there in plazas like inert vestiges of someone's pretended ability to draw himself into a sensibility. I think sculpture should look like it's ready to rip off its foundations. It should be airborne and, literally, able to be launched.

"In the future we won't want an art so controlled by intellectual hierarchy. That is, the entire process from idea to completion would engage matter at a higher energy level. This could bring about an art that is more enlightened about thought processes as they are transferred by and through forms. Today intellect quite often burdens pure energy states and is simply an application—almost like an eighteenth-century decoration. The problem will be, then, how to intercept thought transmission from intellect as it converges into matter. This would be accomplished by the injection of nuance, idiosyncrasy or magic. There is nothing more mysterious than thought, and there will be nothing that art will want to penetrate as much."

• **George Segal** molds life-size figures or fragments of figures and arranges them singly or in groups, usually in an implied setting, to represent human gesture, isolation or moment in time. "The art of a time contains the ideas, subjective states of mind, fantasy wishes and fears of the artists who made the work," he says. "They, in turn, are the surrogate expressions of the feelings of a larger group of people. In the future sculptors will probably try everything from hermetic subjective statements to public, social and political themes in a huge variety of materials and sites. Under elitist standards, critics will select what they think are the most truthful, perceptive and profound works. Under populist standards, work more easily understood by a slice of the general population will be chosen. Every kind of work will be done. Who'll do the choosing—that's the question.

"I find visions of the future that look like hospital operating rooms abhorrent. In my earthbound fashion, I've developed a horror of sterile, shiny, plastic surfaces.

"I think sculpture should look like it's ready to rip off its foundations," says Dennis Oppenheim. "It should be airborne and, literally, able to be launched."

Spaceship and orbital designs will be heavily occupied with inventing environments that possess amazing varieties of textures, humidities, smells and visual and tactile effects that are sensual and life-enhancing."

• **Duane Hanson** is a maker of resin figures that are exact replications of the human figure right down to skin textures and eyelashes. He places them in realistic, everyday situations. For the viewer they can be a visual shock, the impact of normalcy quite unnerving, Hanson says. "As society proceeds into the next century, industry, government and the home will become even more dependent on machines. Art of the future will reflect this reliance on technology. A hundred years from now, though, everyone will be getting tired of it all—lasers, holograms, computer technology—and they will become nostalgic for the Nineteen Seventies and Eighties. Many lasers and computers will be cast aside for art forms made by the human hand."

• **Herk Van Tongeren** works primarily in bronze, incorporating planes, geometric shapes and classical imagery. His sculpture is aligned with surrealism and classical and metaphysical ideas. His outlook: "It doesn't really excite me to look to the future in light of the current trend toward mass values and media. Today there are no widely adhered-to standards of quality in daily life, and as a result, even artists are packaged and peddled and hyped to stardom.

"New technology will surely extend future artists' expressions. Yet there is always the danger that new materials and processes, instead of the artists themselves, will dictate aesthetics. Technology will eventually further an emergent phenomenon. Sculpture, painting, literature, music, and theater, instead of being pursued as separate media, will become one form, a sort of high-tech aesthetic communication.

Some of the sculptors we talked to described pieces they would create beyond the earth's atmosphere.

Acconci: "As a sculptor one hundred years from now, I would like to make a godlike floating person, a human being that could float and expand like a blob from a normal twentieth-century six-foot standard.

"This person could then divide itself into little shelters or houses. These houses would combine into cities, and after they'd been used for a while, they would return to the floating person."

Hanson: "My sculpture, under zero-gravity conditions, might be a sprawling object that could hover in space over a building and function to provide energy and light. At night it would stay in place, lit up, and by day it could be used as a space raft to travel on, like the old magic carpet."

Kienholz: "I would produce a pill to be taken orally that would simulate sculpture images in the mind. I consider the mind and not space as the ultimate frontier."

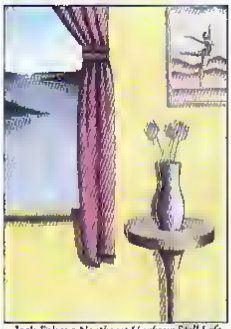
Oppenheim: "I want to be able to dream and make structures materialize from the dreams. A century from now artists should be able to hallucinate matter. During this transaction, art could be used to view the underlying origins of reality, thus circling back into our own psyches to tell us where our pain is from."

Serra: "I have a hard time thinking of the 'if' situations. I feel the materials of now and my present surroundings. I could see, though, doing the work I'm doing now in the next century. What I made would depend on the realities and materials of the future, time, but I think I'd like to be there."

Van Tongeren: "It would appeal to me to create a lost civilization of idealistic and aesthetic orientation. The qualities of this civilization would be conveyed only through ruins and fragments. Just enough information would be present to enhance the enigma."

Witkin: "I would like to be able to make sculpture as rich in emotional dimension as J. S. Bach's music."

What your home could have in common with the Met, the Tate, and the Louvre.



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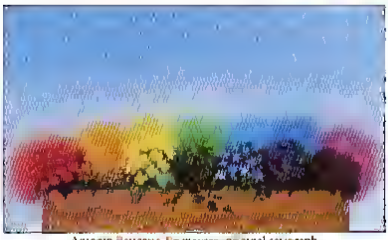

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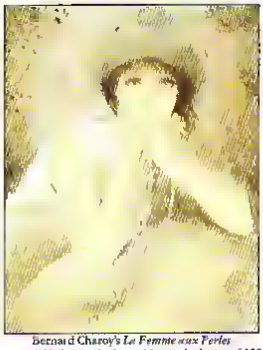

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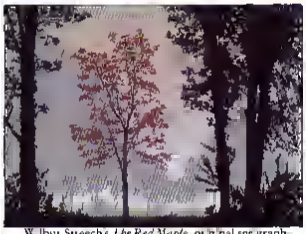

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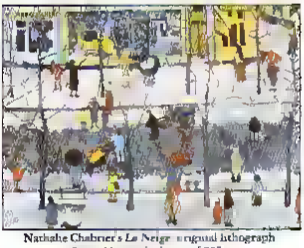

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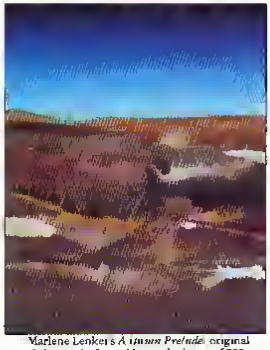

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THE ARTS

By Timothy Bay

Visitors to the conservation department of the Fogg Museum in Boston usually expect to see an antiquarian nest filled with art objects in an atmosphere dusty with the trappings of scholarly research. Instead they find what you'd expect at neighboring MIT—a tableau of white-coated scientists tending a maze of sensitive, high-powered instruments.

The lab at the Fogg Museum is a showcase for the advanced scientific methodology now employed in art museums to analyze and protect art treasures. "Art historians study what they can with their eyes, influenced by enormous training and sophisticated judgment," says Stuart Fleming, scientific director of the Applied Science Center for Archaeology at the University Museum in Philadelphia. The scientist, however, uses equipment to look at what lies beneath the surface, at what can't be seen with the naked eye." Fleming is one of a small group of scientists who are equally at home in art history. The number of museums that have fully equipped laboratories is also small—a mere half-dozen—although across the country there is a growing network of cooperative labs engaged in complex analysis.

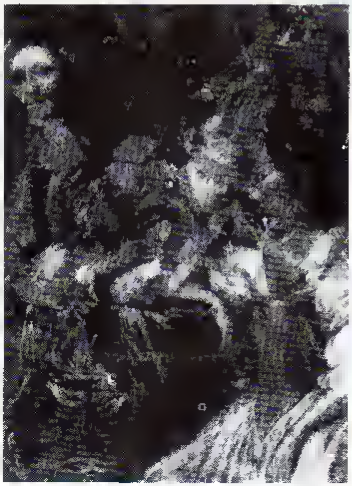
Scientific procedures have gained esteem in the art community by helping to uncover frauds and forgeries. But detecting phony work is usually only a by-product of the larger job of identifying and analyzing the materials and techniques artists used.

The analysis of paint pigments, for example, has helped curators to authenticate paintings. Each pigment has a well-documented history, making it possible to recognize its specific origins. "We know, for example, that certain Flemish painters of the sixteenth century invariably went to special sources for their lead white," explains Garmon Harbottle, senior chemist at Brookhaven Laboratory in Upton, Long Island. "With this knowledge we can study a painting that is attributed to a certain Dutch artist and see whether the lead white matches that chemical profile, or fingerprint."

Curators and art historians fine-tune their study of these pigments through the use of Atomic Age techniques. Neutron-activation analysis, for example, involves subjecting an artwork to bombardment by low-energy radiation. This radiation, in turn, releases gamma rays characteristic of particular elements. By measuring the exact wavelength at which energy is being released, the historian can detect mere jots of substances. Tiny impurities in these trace elements, rather than the gross composition of the pigments, provide a kind of fingerprint that can be compared with the known chemical composition of the pigments available to artists of a certain period.

A textbook example of how pigment analysis works centers on a famous painting, *Merry Cavalier*, attributed to Franz Hals. Although a celebrated art expert testified to its authenticity, there was some skepticism about its origins. These doubts multiplied when technical analysis revealed that synthetic ultramarine, cobalt blues, and zinc white were used in the painting. The earliest of these pigments, zinc white, postdated Hals's death by almost 120 years.

Neutron-activation analysis assisted researchers at the Metropolitan Museum of Art in New York in their investigation of a collection of Sassanian silver from seventeenth-century Persia. "During our study, we suspected that the most spectacular pieces of silverware—the gilt silver plates with ornate hunting scenes—were produced in the royal workshops," recalls Pieter Meyers, who was then a chemist at the Met and is now senior research chemist in the conservation department of the Los Angeles County Museum. "We were able to confirm this judgment, in part, through our chemical analysis. We found through neutron-activation analysis that the silver was of a particular composition that could be traced to a specific origin. We could tell how it was smelted and identify the mines it came from. All this evidence—in combination with traditional stylistic and iconographic analysis—led us to the conclusion that these particular plates had indeed come out of the royal



A NASA technique for processing satellite photos separates two paintings on the same canvas

workshops," Meyers explains.

The treatment of canvas, the undersketching, and even individual brushstrokes can become identifiable through scientific analysis. In a recent study at the Met covering the museum's collection of Flemish art, researchers examined some 35 works by Rembrandt and his school. A technique called infrared reflectography provided investigators with an in-depth perspective of these paintings. A look into the substructures led to a reassessment of the roles played by these great artists. "What we found in some cases was that a member or members of Rembrandt's workshop contributed whole sections of the painting—under the master's supervision, of course," notes Marian Ainsworth, the Met's research investigator on this project. "We recognized differences in the undersketching and the brushstrokes, which made it apparent that more than one person was involved in the painting."

Previously undetected sketches were found underneath several of the Rembrandt works. "Through these sketches we learned a great deal about the way Rembrandt developed his paintings. We were able to reconstruct almost step by step the artistic process," Ainsworth recalls. "We discovered that his technique, his approach, was remarkably similar in the various media—prints, drawings, and paintings. We also gained new insights into how he achieved certain effects, like his celebrated chiaroscuro."

Infrared reflectography helped researchers anatomize these paintings. A camera took a series of infrared negatives of each canvas, producing images resembling X rays of the painting's layers. By analyzing the painting with the infrared spectrum, researchers were able to pick up substructural details that couldn't normally be perceived by the human eye.

Whole paintings concealed underneath the surface painting are sometimes uncovered during technical analysis. Researchers at the Met studying Anthony Van Dyck's *St. Rosalie Interceding for the Plague Stricken of Palermo* uncovered an earlier self-portrait by the artist. Through an X-radiography examination, investigators discovered that *The Absinthe Drinker*, supposedly by Picasso and painted in the manner of his Blue Period, was a fake. X rays revealed a hidden painting with an abstract design—a historical anomaly.

Techniques like neutron-activation analysis leave the painting untouched. Other procedures involve taking a small portion of an object and subjecting it to analysis, although the sample is usually so minute that damage is invisible to the naked eye. Microsampling can be done, using a vibrating needle probe driven by ultrasonic power. Investigators extract a small clump of powder and then analyze it, noting its chemical constituents. One case study of chemical analysis: Scientists in the conservation department of the Smithsonian Institution, in Washington, recently conducted a microscopic investigation of an eighteenth-century harpsichord. "Only small bits of the original harpsichord wire remained," recalls Jacquelin Olin, supervisor of the Conservation-Analytical Laboratory at the Smithsonian. "We analyzed a small fragment of that wire, and the information we gathered helped us understand the kind of sound that was produced by the instrument in its original condition. Now we also know how to duplicate the wire to achieve the same kind of sound as was originally produced."

In addition to aiding such detective work, modern science is also helping to preserve and date artwork. Conservators today have at their disposal powerful simulation tools for investigating the processes of decay and corrosion. "Besides studying the actual forces of corrosion at work," says Lambertus Van Zelst, director of research at Boston's Museum of Fine Arts, "we also run studies in which we artificially decay a small sample of a work so that we can understand how a sculpture, for instance, will age." One technique is to bombard the sample with ultraviolet light and see how it reacts. Ultraviolet light is one of the more damaging forces attacking outdoor art. "We don't always know precisely what kind of conservation materials we should be using," Van Zelst says. "By testing the materials out beforehand on a sample, we can get a better idea of the long-range impact of some of these conservation materials."

"By means of X radiography, investigators discovered that The Absinthe Drinker, *supposedly painted by Picasso during his Blue Period, was a fake."*

Chemists determining the age of ceramics and other artifacts employ another technique, thermoluminescent dating, to measure the natural radioactive decay of minerals. All minerals over time absorb a number of extra electrons among the atoms that make up their crystals. When the crystals are heated in the laboratory, these electrons, in turn, are released from the object. The extent of the release is proportional to the amount of radiation that has accumulated since the time the piece of pottery was fired. Measurement of the release during heating provides accurate information about the date of an object's creation.

Thermoluminescent dating can be a very handy tool for art historians. Arthur Beale, director of the conservation department at the Fogg Museum, described how thermoluminescent dating helped the museum recently in its evaluation of a Chinese ceramic horse from the Tang dynasty. "We noticed right away that we had to be careful with this authentication, since the horse's head as well as the rider on it had broken off and been reattached. The question was whether the horse had been broken naturally and put back together or whether the fragments of the horse's head and the rider were not part of the original, but had been added on to increase the value of the work." Through thermoluminescent dating it was found that the body of the horse was indeed from the Tang dynasty. But the other pieces were of more recent vintage. "This is a typical problem confronted by a museum or private collector," says Beale, "the attempt to increase the value of a work of art by adding pieces, by artificially making it whole."

Sometimes discrepancies are not the result of deliberate deceptions. Beale notes, "There were obvious stylistic inconsistencies in a pair of fifteenth-century French terra-cotta heads that were offered to us. Through thermoluminescent dating, we found that twenty percent of the object derived from restoration work that was done in the nineteenth century. In this case this process helped us isolate precisely what had been done to the work. The restoration work did not devalue the artwork."

This kind of knowledge does not come cheaply. The replacement value of the equipment at the Boston Museum of Fine Arts, Van Zelst reveals, is close to $750,000. "That may not sound like a lot of money when you are talking about scientific research. But you have to realize that most museums have relatively small operating budgets." Since it involves the use of a reactor, neutron-activation analysis is an expensive procedure. "The cost of examining one painting can be several thousand dollars and involve a whole month's work," says Harbottle.

Despite the high price tag, there is both real cost-saving value and immeasurable scholarly worth in this technology. It can help a museum safeguard its reputation by preventing the embarrassment of buying an artwork that might later prove to be a forgery. "Besides museums, more and more private collectors want to make sure they are getting what they are paying for. You have to remember," adds Fleming, "that just as our knowledge of the materials becomes more sophisticated, so do the techniques of those who make forgeries."

THE ARTS

By Charles Platt

There's a publishing boom in books about computers, and it's easy to see why. Last year Americans bought more than a quarter-million personal computers for use at home or in small businesses. Many proud new owners lacked technical knowledge and found their instruction manuals hard to understand. So, naturally enough, they turned to independently published guides for help.

Meanwhile, for each person who ran out and splurged $1,000 or more on today's most fashionable electronic toy, perhaps two or three others approached the subject more cautiously. These skeptics bought books to find out how computers work, which brand they should choose, and what they could and could not do with one if they owned it.

The net result of this is that computer books have been selling as never before, and publishers are turning out dozens of new titles every month.

Unfortunately, in the scramble to publish as many computer books as possible, publishers have rushed out amateurish guides written by computer freaks who know their subject but don't know how to explain it clearly. "Customers ask me which guide I recommend," a New York computer-store owner complained to me recently, "and I tell them *BASIC and the Computer* by Thomas A. Dwyer and Margot Critchfield [$12.95, Addison-Wesley, Reading, Mass.]. That came out five years ago, so it's somewhat dated now. But it's quite a bit easier to understand than the new books I've seen recently."

The opportunistic tactics that some publishers employ can also contribute to low standards in computer books. Anyone who writes a short article for one of the computer magazines, for instance, will have his name picked up by at least a couple of book publishers, who'll send form letters encouraging him to write a book for them on any computer-related subject, regardless of his qualifications. Indeed, some book publishers prefer to hire amateurs because they are less trouble to work with. A would-be writer excited by the prospect of seeing his work in print won't complain if the publisher makes changes, and he will do the work for lower pay.

A skeptical book buyer can detect and avoid the obviously cheap exploitative books by careful browsing. But even some reputable books by professional authors can turn out to be much less useful than they seem. For example, the second edition of *Personal Computing*, by Daniel R. McGlynn, published this year by John Wiley and Sons, of New York, in hardcover for $14.95, is very authoritative and thorough. It surveys the whole field and includes a master list of every computer manufacturer and retail outlet from the Itty Bitty Machine Company, of Evanston, Illinois, to your local Computerland franchise. And the book is nicely written. However, the unlucky reader who lacks a science background will find that the explanations are hard to understand. On one page the author carefully describes, in words of one syllable, how a computer counts in ones and zeros. On the next page he leaps suddenly ahead into the arcane language of baud rates and machine code. To him, as an expert, it's all much the same. To any reader who hasn't a technical background, it becomes incomprehensible. And the impressively complete listing of computer stores is really no more helpful than your local Yellow Pages.

Another book that looks like a winner but turns out to be disappointing is *Without Me You're Nothing* (Pocket Books, $5.95), by Frank Herbert, author of the best-selling science-fiction novel *Dune*. Herbert claims he's out to debunk and demystify computers, but he has a techno-freak's love of jargon, and the book is full of sweeping generalizations that betray a lack of firsthand experience. It will intimidate and baffle the reader who does not already own a computer and doesn't know the language.

An infinitely more useful and better-researched handbook is the small, modest *Checklist/Guide to Selecting a Small Computer*, by Wilma E. Bennett, published by Pilot Books, of New York, for just $5.

Now that you've spent all your cash on a flashy new computer, what are you going to do with it?

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3-D TV

BREAKTHROUGHS

By Phoebe Hoban

Remember *Bwana Devil*, *Creature from the Black Lagoon*, and Andy Warhol's *Frankenstein*? Besides their monstrous plots, these movies have another thing in common. They weren't meant to be viewed with the naked eye. To see these films for what they really are, entire audiences have to don ridiculous-looking 3-D glasses.

Now 3-D classics are being broadcast on television, and the extra dimension seems to appeal to prime-time audiences everywhere from Louisiana to Hamburg. When a local TV station showed *Revenge of the Creature* in New Orleans, riot police had to restrain the public from storming retail outlets that rapidly ran out of the special glasses. Last February, 8 million TV viewers in West Germany put on 3-D spectacles to watch a made-for-TV extravaganza called *When TV Pictures Turn to Plastic*.

But new technology for 3-D television may turn the familiar cardboard glasses into antiques. From independent inventors to industry giants like Sony, engineers are experimenting with "autostereoscopic" 3-D TV systems which don't require special viewing aids.

Current 3-D technology dates back to a Victorian fad—the stereoscope—double-barreled lenses through which a pair of adjacent photographs (one for each eye) were viewed. The convergent image appeared to have depth and perspective. The method used for most 3-D movies achieves the same binocular effect by color separation. The viewer wears glasses with a left and a right lens colored red and green, respectively, to correspond to color-coded images in the film. Each eye sees the same image from a slightly different angle, creating a 3-D effect. More advanced technology, like the Stereospace 70mm movie system developed by United Artists, uses polarized glasses instead of bicolored ones to filter images to each eye.

But at Sony in Tokyo, scientist Yuzuru Yanagisawa has found a way around 3-D glasses. Using the company's Trinitron television tubes as building blocks, Yanagisawa has constructed a seven-foot-tall television projector. This directs different images through a Fresnel lens into each of the viewer's eyes. The so-called Mayko system is still a laboratory prototype, but Yanagisawa believes that an autostereoscopic 3-D system could be available to consumers by 1990.

James D. Butterfield, president of 3-D Video Corporation, in Los Angeles, broadcast his first 3-D TV show in Mexico in 1953. "Three-D television without glasses will be a reality in the near future," Butterfield predicts. "It will be every bit as popular as color television is today. In ten or fifteen years you won't know whether the Johnny Carson in your living room is a video image or flesh and blood." In the meantime, Butterfield has built a laboratory model of a 3-D system that uses multiple TV cameras to project an image onto a lenticular (ridged) screen. "We can project an image of a woman whose nose protrudes clear out of the screen," says Butterfield. "You can shake hands with her or view her from a one-hundred-eighty degree angle."

Dr. Robert McElveen, an optometrist in South Carolina, has approached 3-D imaging from a totally different perspective. His system, currently under development by Tri-Dimensions Inc., of Los Angeles, uses an ordinary stereo camera to shoot the film, which is then specially processed so that each frame contains a selected right- or left-eye shot. The processed film is projected through a special lens. The frames are viewed in such rapid succession that the different views are perceived as a single, fused 3-D image.

Scientists at Biofuel Inc., a small Costa Mesa, California, firm, were actually developing an electronic geological surveying system when they stumbled onto the technology for a unique 3-D TV set. Biovision uses solid-state imaging technology and lenses and mirrors to project life-size images into a "cone of vision" in front of the screen. Secretive company officials will disclose very little about the technology, but vice-president Errol Payne says that it works very much like the flight simulators used by pilots. Biovision will make its first appearance this

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Gill Man and girlfriend leap off the screen in Creature from the Black Lagoon, *vintage 3-D*

ANTARCTIC ADVENTURE

EXPLORATIONS

By Delta Willis

When in the 1960s Lars Lindblad first suggested taking tourists on a cruise of the Antarctic, many a brow furrowed and the doubters sang their usual refrain No way Who would choose this land of the wrong superlatives—the coldest windiest and toughest—over basking on a sunny beach? "Great God! This is an awful place " wrote Robert Falcon Scott in his diary just before perishing in the 1911 race to the South Pole Roald Amundsen, the first man to plant a flag at the bottom of the earth, survived by eating his sled dogs

Yet Lindblad knew Antarctica as a thrilling stage for some of the world's most fascinating creatures The continent is a vast panorama of whiteness majestic interruptions of jagged blue cliffs icicles that glitter and dazzle the eye Here half a million penguins gather at one spectacular black-tie party, 43 species of seabirds thrive and vast floating pastures of krill, possibly the protein source of the future feed the great whales

So the dynamic Swede, with a full decade's jump on the burgeoning market in adventure travel, set out to design an unconventional vessel, converting ballroom to lecture hall and filling the podium with scientists and naturalists

Now in its twelfth year of cruising to remote places around the globe, the *Lindblad Explorer* is booked months in advance On board marine biologists anthropologists and ornithologists conduct seminars on a wide variety of topics from whale migration to the mating dance of the albatross Although group lectures focus on subjects of broad interest more technical discussions often dominate the small informal gatherings On the ship's deck one may find bird-watcher Robert Tory Peterson behind binoculars teaching passengers the distinction between a royal penguin (*Eudyptes schlegeli*) and a king penguin (*Aotenodytes patagonica*) Scientific genera are noted as are the technical names of the ice blocks that float by below "Brash" is the term for pieces less than six feet in diameter a "growler" is the size of a Manhattan terrace a "bergie bit" larger still and true icebergs may exceed the ship's 250-foot-long hull

In the evening Bengt Danielsson may tell of his voyage with Thor Heyerdahl on the *Kon Tiki* and Sir Peter Scott son of the explorer may ponder the evolution of the flightless penguin During the day however there is less time for reflection Quiet moments may be interrupted by the unexpected such as the sighting of an uncharted island on the horizon Such grand occasions are inevitably marked by the uncorking of champagne and the launching of rubber Zodiacs

Of course the unforeseen can be hazardous as well as rewarding The cruiser has run aground twice most recently under charter to a Japanese film crew shooting the science-fiction thriller *Virus* Yet the *Explorer* has survived these accidents to become a trend-setter as well as a trailblazer

Since the *Explorer*'s maiden voyage numerous vessels have followed in her wake In addition to Antarctica one can discover Darwin's Galápagos, snake along the tributaries of the Amazon or be greeted by the chant of New Guinea's Asmat warriors their painted bodies erect in a flotilla of dugout canoes The *World Discoverer* chartered by Society Expeditions not only offers similar destinations but mimics the *Lindblad Explorer* in design philosophy and even color a brilliant red Lindblad's own son Sven Olof under the banner of Special Expeditions has Explorer ships that meander through the gulfs of California and Alaska

Travel in primitive unspoiled areas requires the wisdom of a conservationist and the patience to proceed with caution Even the design of the *Lindblad Explorer* Lars Lindblad explains was based on ecological considerations "She was built small to accommodate only ninety-two passengers so that the impact on fragile environments is minimal The impact of three hundred fifty people coming to a penguin rookery can be fatal"

Finding "tourism the greatest benefactor of wildlife and natural beauty, Lindblad

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The Lindblad Explorer approaches a penguin rookery at the edge of Antarctica's Ross Sea

CONTINUUM

Edited by Dick Teresi

REEFER MADNESS

After nearly a decade of treless work, the drug industry giant Eli Lilly has scored a unique triumph. Its new drug, nabilone, has finally been approved for use in human patients, at least in Canada.

What is remarkable about this is that nabilone is the first tangible product of one of the most bizarre research efforts in modern medicine. In dozens of major laboratories across the United States an army of doctors, chemists, and pharmacologists is spending millions of dollars on a probably futile attempt to take the high out of marijuana.

This is not a plot by the government or by Moral Majority conspirators, though it seems likely that both groups have helped to inspire the research. Rather, it is one more tribute to the healing art's most honored principle: Before a medicine can do a patient any good, it has to taste like hell.

Why the enormous scientific interest in marijuana? Because twentieth-century physicians have rediscovered what fifth-century alchemists could have told them: *Cannabis sativa* is more than just a high, the stuff can be good for you. In fact, the list of diseases that may be cured or controlled with liberal doses of hemp has been growing continuously for more than a decade. It already includes nausea suffered by patients undergoing cancer chemotherapy, glaucoma, anorexia nervosa, epilepsy, bronchitis, amoebic meningitis, hypertension, and more.

Harvard University's Dr. Norman Zinberg usually gets the credit for rediscovering the drug's medicinal properties. While treating cancer patients with chemotherapeutic drugs so powerful that they caused severe nausea, the doctor noticed that some of his younger patients handled the chemotherapy surprisingly well. It didn't take him long to find out why. They were heavy pot smokers. Dr. Zinberg published the first report on the controlled use of marijuana in conjunction with chemotherapy in 1976, along with researchers at the Sidney Farber Cancer Institute, in Boston; their work has since been replicated in many other hospitals.

Another breakthrough was the discovery that marijuana could be used to treat glaucoma. While doctors were busy conducting experiments with the drug, trying to prove it really was an effective treatment that didn't produce undesirable side effects, a District of Columbia court ruled that the Food and Drug Administration must license a local ophthalmologist to prescribe joints to control patient Bob Randall's glaucoma. Randall is now about the only person in the country who can walk into a drugstore and—legally—buy marijuana cigarettes.

Yet instead of welcoming marijuana as a versatile "new treatment, the medical community has seemed scandalized. Typical is the reaction of a Georgia doctor who editorialized in the *Annals of Ophthalmology*: "The 'high' makes it totally unacceptable as a 'medicant [*sic*].' The side effects inflicted upon the recipients . . . certainly outweigh any conceivable benefit." Side effects? The one side effect the doctor complained of was that dreamy euphoria experienced by three quarters of the people who smoke marijuana for medical or recreational reasons.

It's become clear that doctors will probably never prescribe marijuana until the labs have found a way to take the fun out of it. So researchers are devoting as much attention to that effort as they are to exploring new medical uses for this age-old drug. Using *Cannabis sativa* grown on a U.S. government plantation hidden somewhere in Mississippi, chemists have already isolated 420 complex organic chemicals from the plant. Of these, one seems to have a monopoly on medicinal potency: delta-9-tetrahydrocannabinol, THC for short. And the high? That also comes from THC.

Once THC had been isolated, the next logical step was to create synthetic versions that might be more potent or less enjoyable. Nabilone was the first of these. Eli Lilly and Company has been testing it since 1974. One advantage nabilone has over natural THC is its long shelf life. Natural THC deteriorates rapidly once it's extracted from the plant. A disadvantage is that nabilone is expensive: one licit dose costs about ten times as much as an illicit joint. And it gives the same high as nature's own THC. Despite this, doctors are more likely to jot "nabilone q.i.d." on a prescription pad than "four joints a day."

Dr. Zinberg thinks the medical establishment should stop wasting millions on trying to take the high out of pot. He points out that in the past 15 years some 51 million Americans have medicated themselves with marijuana—without measurable harm, according to most scientists. In fact, three out of four patients who've taken doctor-prescribed THC insist that they find nothing objectionable in its much-mistrusted side effect.

—*FRANKLYNN PETERSON AND JUDI KESSELMAN-TURKEL*

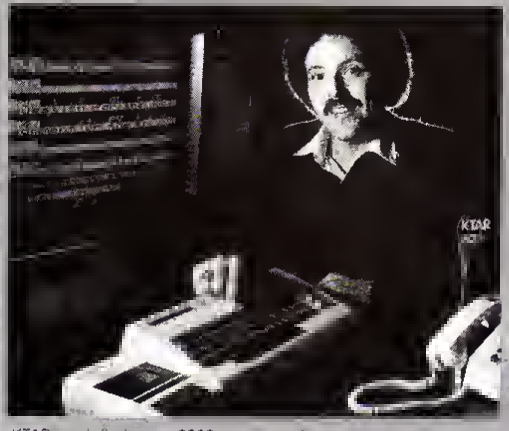
CONTINUUM

THE JERK FINDER

The airwaves are filled with radio call-in shows that seem as unpredictable as next week's weather. "It is a lot like playing Russian roulette," says Jim Taszarek, vice-president and general manager of station KTAR-AM in Phoenix. "Since the calls generally are answered at random, the interviewer would have to be psychic to know whether the next caller will be interesting or crazy—or worse yet, boring. The interviewer just answers the phone and hopes for the best."

But now KTAR has found a way to make call-in shows less of a gamble. A producer fields the calls and, using a simple $300 computer equipped with a program dubbed "the jerk finder," enters pertinent information about callers on a TV screen. That information—including each caller's age, geographic location and question—is then relayed to a terminal in front of the show's host. There are even codes to alert the host to the demeanor of the callers. Are they hostile, for instance, or merely drunk?

By quickly scanning the screen, the host can review his options and plug in to only those callers who will enhance the conversation. "If the show is terribly dull," Taszarek explains, "the host might want to tune in a hostile person to get some excitement." Or if it is a sports show and the subject under discussion is baseball, the host can leave "on hold" those individuals who insist on talking about basketball.



KTAR's jerk finder is a $300 computer that projects pertinent information about talk show phone callers on a TV screen

What's more, the station can use the enormous memory capability and mathematical prowess of the computer to collect information about the number and types of callers who respond to different shows. "We can figure out which topics we should repeat and which we should drop for lack of interest," Taszarek says. "A radio show is successful only if it responds to the needs of the community. The computer helps us do just that."

—Bethany Campbell

"Luckily for mankind there are always enough adults who retain their juvenile inventiveness and curiosity and who enable populations to progress and expand."

—Desmond Morris

YOUTH HORMONE

Most animals, including humans, are born with immature brains. Their youthful nerve cells are only crudely "wired," able to acquire new functions simply by growing or branching out, to other areas of the brain. Such "plasticity" is lost by the time animals reach maturity, when nerve cells stay much the same until they wither and die.

But now neurobiologist Fernando Nottebohm of Rockefeller University in New York has learned that this rule does not apply to male canaries. In the spring, when male canaries learn new songs to attract female canaries, two clusters of cells in the male forebrain enlarge. When fall comes, the males stop singing and the clusters shrink. Nottebohm even has an explanation for all this. Cells in the adult male canary brain, he suggests, branch out in much the same way as the nerve cells of the human infant.

Nottebohm's previous work revealed that the canary's ability to sing corresponds directly to seasonal fluctuations in levels of the male sex hormone testosterone. When canaries wax lyrical in the spring, their testosterone level is especially high. When they refrain from song in the winter, their testosterone level plummets. If female canaries are injected with testosterone, they also break into song.

The adult canary's plastic brain can expand or contract

Nottebohm is trying to learn just what is responsible for plasticity in the canary brain. If he can isolate a plasticity hormone, he says, he might be able to "learn to make up for the loss of brain cells caused by aging or injury in humans."

—Carol A. Johmann

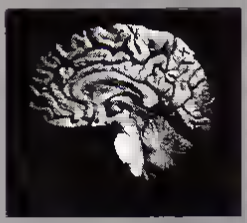
"You know, there are three kinds of intelligence—the intelligence of man, the intelligence of animals, and the intelligence of the military. In that order."

—Gottfried Reinhardt

BRAIN PENETRATORS

The brain sends its instructions to every part of the human body. Yet when physicians want to communicate with the brain, they are prevented from doing so by a potent shield called the blood-brain barrier— a hard-to-penetrate lipid membrane covering the capillaries that carry blood past the brain.

Although tiny nutrient and oxygen molecules can pass through the capillaries to energize the brain, larger



The goal is to make drugs that can penetrate the brain

substances, including blood and therapeutic drugs, cannot.

Chemist Nicholas Bodor reasoned that a drug just *might* pass through this barrier and into the brain if it were lipidlike itself. So, in a complex series of steps, he and his coworkers hooked a variety of drugs to lipidlike carrier molecules, then injected the concoction into rats.

Once this step was complete, Bodor found, the lipidlike drug did indeed leave the capillaries and enter the cells of the brain. Once inside a cell, the drug became separated from its carrier. Since the drug was no longer lipidlike, it could no longer pass through the blood-brain barrier's impervious lipid membrane. The result: The drug stayed locked in the brain and got to work.

So far, the researchers have gotten phenylethylamine (similar to dopamine) and an anticancer agent called berberine across the barrier in rats. They are currently trying the same technique with contraceptives, tranquilizers, analgesics, and drugs for epilepsy.—Carol A. Johnmann

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"Like democracy, science succeeds in the long run not because its luminaries are free of error but because they are often found out, sooner or later nature puts an end to nonsense by delivering its verdict in a suitable experiment."

—Nigel Calder

The agony of running into the 20-mile marathon wall. Prostaglandins may be at fault, and aspirin may be the preventative.

ASPIRIN FOR RUNNER'S WALL

Twenty miles into a marathon race, runners often smack into "the wall," a barrier of pain and fatigue. Dreading it, seasoned marathoners try to avoid it through diet and conditioning, usually to no avail. Now a Pennsylvania doctor believes that he has come up with a better way.

Taking a dose of aspirin before the race will do the trick, says Dr. Laurence Demers, a clinical pathologist at the Milton S. Hershey Medical Center.

Demers studies prostaglandins, fatty acid substances that regulate body temperature, blood pressure, stomach acidity, blood clotting, and muscle contractibility. They also concentrate in higher than normal amounts in runners' bodies during a race and build the wall, leading to cramps, nausea, and lightheadedness.

After a casual inquiry from a runner, Demers, knowing that aspirin inhibits prostaglandin synthesis, investigated the phenomenon during the 1980 Harrisburg (Pennsylvania) Marathon. He and Dr. Richard Santen found higher than normal concentrations of prostaglandins in 20 men and 4 women runners.

Demers's research into prostaglandins and aspirin is providing numerous clues as to "how aspirin works," he says. For instance, "an overabundance of the prostaglandin that constricts blood vessels will cause headaches." His work includes investigations of how aspirin thins the blood and in some cases how it may thicken it. "The initial data do not always show aspirin to be beneficial," he notes. "But by using the knowledge we have gained, we can synthesize analogs that would be more selective. There is great potential here for regulating clotting in patients who need coronary-bypass surgery."

Thus, although runners may be pleased to know they can avoid the wall, Demers is more excited by other prospects of his research. "That was probably the least significant thing I've found out about prostaglandins," he admits.—Allan Maurer

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"Before thirty, men seek disease; after thirty, diseases seek men."

—Chinese proverb

CONTINUUM

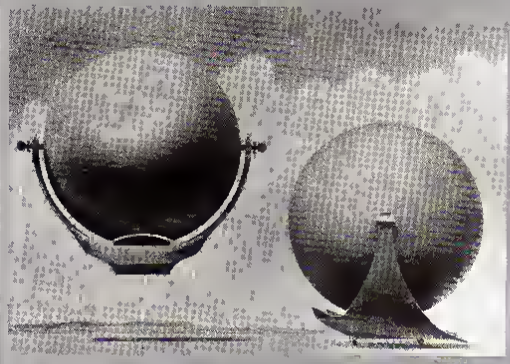
A BETTER BLIMP

Imagine a giant manta ray floating through the air its upswept wings cradling an 18-story sphere A vehicle fitting just that description is the newest thing in blimps and Ottawa inventor Frederick Ferguson expects it to be the first of a new generation of lighter-than-air (LTA) transports

Although blimp development languished after the explosion of the hydrogen filled *Hindenburg* in 1937 dozens of safe helium-filled models are now on the drawing boards But Ferguson says his manta-ray design is the first to address what he calls the major fault of dirigibles—their awkward and unwieldy cigar shape

Ferguson's ship is a pressurized, helium-filled sphere suspended from a horizontal bar that runs between the "wingtips" of a manta-ray shaped yoke Twin engines mounted on the bar rotate the sphere slowly lifting it from the ground by the same aerodynamic principle that sends a spinning golf ball or tennis ball soaring When cargo is removed from the manta-ray base thus altering the weight of the craft the sphere simply takes on air to maintain buoyancy

Ferguson s company Van Dusen Commercial Development Canada Ltd has already built and flown a 20-foot-diameter prototype The 180-foot full scale model the inventor says should be able to haul up to 80 tons, four times as much as the largest helicopters and do it for a tenth of the cost At top speed—70 mph—its range will be 550 miles At half-speed it could travel as far as 2,000 miles without refueling



Artist s conception of new lighter-than air transports Engines mounted on the crossbar rotate the sphere to provide lift

LTAs are likely to be used for hauling giant sections of prefabricated buildings transmission towers, pipelines or offshore oil rigs and for unloading fish from ships at sea Some potential users say the new blimps might even help them float water across the Middle East —Yvonne Baskin

"When you collect the ten wisest men of the world and ask them to find the most stupid thing in existence they will not be able to find anything stupider than astrology'

—David Gilbert

"Nothing in life is to be feared It is to be understood"

—Marie Curie

INVISIBLE BRACES

Orthodontic patients have always been easy to spot in a crowd They give themselves away with the first gleam of their silvery smiles But now Ormco a leading manufacturer of orthodontic materials in Dallas, is bringing invisible braces onto the market after several years of research and testing

Instead of completely wrapping each tooth with a stainless steel band, the newly developed system hides the metal Small brackets are bonded only to the back of the teeth with a rapidly setting adhesive The forces to reposition the teeth into proper alignment are then exerted by spring wires held within those hidden brackets

This aesthetic improvement, however, is not without its drawbacks During office visits every four to five weeks, the orthodontist can take up to twice as long to make the necessary adjustments because the invisible braces are harder to work on Test patients have also reported that the tongue gets sore speech is slurred and chewing food is difficult during the first month of wear

On the other hand some of the 400 patients now wearing the new appliance have been known to miss their monthly appointments because they forgot they even had the braces on

—Marcia F Bartusiak

Ormco s new hidden braces rely on small repositioning brackets bonded to the back of the teeth with a rapidly setting adhesive

BABY MAKERS, INC.

Falling birth rates and the breakup of the traditional family in the United States may one day lead to government-subsidized baby-making Temple University sociologist/demographer Joseph McFalls declares

Citing a battery of statistics McFalls notes that ' with the exception of the baby boom, the birth rate has been falling in the United States almost since the beginning of the Republic Currently it is at 1 8 children per couple, below replacement level

"Many factors suggest that the birth rate will continue to decline, the demographer says These include the growing economic independence of women, the fact that people are choosing not to get married and are spending less time married when they do, and the rising cost of raising children

' Increasingly better birth-control methods legalized abortion and lower fertility rates are also factors The United States will achieve zero population growth by the early twenty-first century and population will begin to fall by 2020 if not before

If this is perceived as a problem—"and it often is, for reasons of prestige or military security,' McFalls says—the American government may as some European countries already do offer mothers financial incentives to have children ' Today the United States is the fourth-most populous country in the world What if we became the fortieth? ' McFalls asks

If birth rates keep falling and the traditional family continues its decline corporations may have to take over the task of procreation

Should even financial incentives fail the government will probably turn to corporations These he believes would use advanced *Brave New World* techniques—test-tube babies artificial insemination, embryo implantation and group children s homes—to make baby-making a business

' Although this sounds like science fiction ' McFalls adds "it s really not so unusual for one institution such as the family, to give up some of its functions to another such as government Families used to be responsible for the education of children and the care of the aged The government does both now

—Allan Maurer

'If a minister believes and teaches evolution, he is a stinking skunk "

—Billy Sunday

BREAST CANCER IN DOGS

Breast cancer shouldn t happen to a dog but it *is* a common ailment in older female canines And the outlook hasn t been bright Mammary tumors can be removed surgically but most dogs die within 18 months

In San Antonio, Texas however, 90 percent of pet dogs injected with bacteria called *Bacillus Calmette-Guerin* (BCG) are still alive and barking 19 months after surgery The two scientists who devised the treatment Drs Steven Harris and Wendell Winters of the University of Texas Health Center report that *all* dog tumors show some reaction to BCG Up to 80 percent of the tumors are destroyed and a few disappear completely Blood samples taken from treated dogs at the time of surgery show an abundance of antibodies and the virus-fighting protein interferon In fact Dr Harris says since most treated dogs are still thriving BCG may be working on cancer that has spread too

Pet dogs make good subjects for a breast-cancer study according to the researchers The animals develop cancers similar to those found in humans they have similar immune systems and they live in the same surroundings BCG will require testing by the Food and Drug Administration before being used to treat human-breast cancer but the agent may be available to veterinarians for use on dogs within a year

—Barbara Ford

Researcher Dr Steven Harris holds a vial of BCG

"To have arrived on this earth as the product of a biological accident, only to depart through human arrogance would be the ultimate irony '

—Richard E Leakey

CONTINUUM

FAST-AGING WORMS

White rats and guinea pigs may be better-known animal-research subjects, but "the ideal specimen for studying human aging is a microscopic worm called *Caenorhabditis elegans* according to a North Carolina geneticist.

Dr. Paul Goldstein of the University of North Carolina at Charlotte, studies the chromosome structure of the tiny worms under an electron microscope. "We have to study an organism that goes through changes in the aging process similar to those of humans, but more quickly," he says. Not only do these worms have chromosomal structures like those of humans, but they even develop age spots and have difficulty holding their water as they age. They reach this stage however, in ten days. Three-and-a-half days after birth they're adults. In five days they're old, and not long after that they're dead," Dr. Goldstein notes.

His study of the worms has already produced exciting results. "By looking at threadlike structures that appear on chromosomes during reproduction we can locate, for the first time, a specific gene on the chromosome. When thought of in connection with current work in genetic engineering, this is very important," Goldstein says.

"A single gene duplication that leads to a specific mutation," he explains, "can be pinpointed, say, two to four microns from this end or whatever. In genetics this is as necessary and important as knowing where your house is on a particular street."

In another discovery Goldstein located a structure on the worm chromosome that results in the "one bona fide male in ten thousand of the normally hermaphroditic worms."

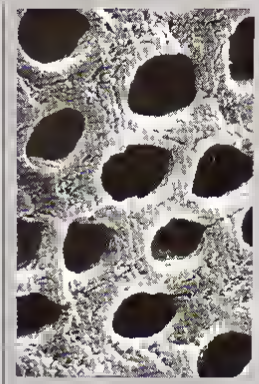
Only a handful of people worldwide are studying this species. One reason for this is that care of the stock, conducting control experiments, and performing electron-microscope work can be tedious. Another reason may be the size of the subjects. To get at the chromosomal material used for study, Goldstein must surgically remove their gonads under a dissecting microscope. How does one operate on something the size of a grain of salt? "With a steady hand," Goldstein says.

—Allan Maurer

Studying worm chromosomes is an exacting exercise

"Life can only be understood backward, but it must be lived forward."

—Søren Kierkegaard



Photomicrographs of tooth surfaces. A Russian experiment holds out promise for growing brand-new teeth from 'dental germs'

GROWING NEW TEETH

Are you losing your teeth? If you don't relish the thought of wearing dentures, you may instead soon be able to grow new permanent teeth.

Researchers in Daghestan, in the USSR, have developed a method of transplanting teeth by using "dental germs" obtained from donors. A dental germ is a tiny mass of bone tissue that develops into a normal tooth.

"The concept of the method is not new," explains Magomed Maksudov, chief of the research team. "Tooth transplant experiments on animals go back to the nineteenth century, but there has always been the problem of rejection."

Maksudov found he could lower the rate of rejection by freezing the dental germs in liquid nitrogen before transplantation. His researchers were able to transplant teeth successfully first in dogs, then in young people, and now in adults. "We made transplants to twelve patients who either had no teeth from birth or had lost them because of diseases," Maksudov says.

Donors of dental germs must be children with undeveloped teeth. Donors can be either dead or alive. If alive, the child will not be able to grow the tooth if the bud is removed. However, most children have at least four dental germs they can donate without missing the teeth later in life—the germs for their wisdom teeth.

Transplants are done in blocks of three or four germs. Teething begins in four to five months, and within a year the new teeth have developed roots.

So far none of the 12 adult patients have rejected the dental germs, and everyone seems to be teething nicely.

—Donna Cheshire-Engler

SMELLING T-SHIRTS

Take a deep sniff now, and tell me Whose dirty T-shirt is this? Richard Porter has been asking people this question, and he's come up with some surprising answers

Porter a psychologist at Vanderbilt University, in Nashville Tennessee thinks we give our sense of smell a lot less credit than it's due To test that idea, he gave 12 pairs of siblings identical white T-shirts The kids wore the shirts to bed each night and stored them in plastic bags during the day to prevent contamination by other odors After three nights 19 of the 24 children could pick out their sibling's shirt by smell alone

Then Porter tested parents---ten mothers and eight fathers All but two could tell their children's shirts apart "We found it a lot harder to get fathers to join the study he notes "They didn't want to take it seriously The mothers were intrigued by the idea '

Porter has found that mothers can identify their children within two days after the infant is born He doesn't know yet whether the awareness is genetically endowed or learned, but he hopes to test this by working with women who are seeing their newborn infants for the first time

Porter says his colleagues like to poke fun at him, and he attributes this to our cultural training We tend to be very inhibited about body odors,' he points out "much more so than some other cultures In the Middle East intermediaries arranging a marriage for a third party sometimes turn women down because of their odor '—Owen Davies

'Most bad habits are tools to help us through life '
—Johann Wolfgang von Goethe

Children can identify their siblings from the smell of their T shirts mothers can smell-identify their babies two days after birth

COMPUTER EPILEPSY

The latest clues to the cause of epilepsy are coming not from the brain but from a computer

Doctors already know that localized, or focal, epilepsy springs from a ridge of gray matter called the hippocampus deep within the brain Nerve cells there normally fire off a pulse of electricity every second or so, seemingly at random But just before a seizure hundreds of cells fire in a sudden burst, producing a sharp spike" on brain-wave recordings

No one knew why these bursts occurred until Dr Roger Traub a computer scientist working for IBM and Dr Robert Wong, of the University of Texas decided to combine lab studies of the deep-brain tissue with computer simulations of nerves What they produced was a model of the nerve-cell bursts that provided a surprising insight

"Understanding how a single cell gives off a burst proved more difficult than simulating a whole network of bursting cells, Dr Traub recalls One key was to include information about the brain cells of snails and other primitive creatures ' Data from mammals alone did not produce these bursts he says

The computer showed that it takes only one malfunctioning cell to set off a burst, in a kind of chain reaction Now it "is starting to make predictions of how this could go wrong and lead to something that looks like a seizure," Traub says

According to the computer model he notes one cell burst does not actually cause a seizure "But it helps to identify other variables that might The real benefit of the model is to get researchers to look for things they wouldn't otherwise think of '—Allan Maurer

IBM's Roger Traub uses the computer to study the brain

"If you should say, 'It is enough, I have reached perfection ' all is lost For it is the function of perfection to make one know one's imperfection "
—St Augustine

"Stay young by hanging on to your dreams There is not much to do but bury a man when the last of his dreams is dead '
—Wilfred Peterson

CONTINUUM

Hair loss is a common side effect of chemotherapy

MAGNETIC PILLS

Chemicals that destroy cancer cells can have devastating effects on healthy cells as well So doctors who treat cancer patients with chemotherapy drugs are often faced with an insoluble dilemma If they deliver too much of a drug the patient might die of side effects if they don't deliver enough the patient will succumb to the cancer itself

Now there may be a solution Scientists at Massachusetts Institute of Technology s National Magnet Laboratory have developed tiny pills coated with protein and ultrafine magnetic particles These magnetic micropills filled with chemotherapy drugs, are injected right into an artery supplying a malignant tumor The part of the body harboring the tumor is placed in a magnetic-field device that attracts the pills A highly concentrated drug reservoir forms in and around the tumor as the drug leaches out of the pills

Since only the tumor is affected and the drug does not travel elsewhere in the bloodstream micropills can be used to deliver 100 times more of a drug than conventional chemo therapy The result Massive quantities of the drug guarantee that tumor cells will meet certain death

According to molecular physicist Barry Sears formerly of the National Magnet Laboratory and now president of a company researching and manufacturing magnetic micropills, experiments with rats show that magnetic-micropill chemotherapy works In one test, 80 percent of those rats first injected with a lethal sarcoma cancer and then injected with the anticancer drug adriamycin died But 90 percent of the tumors went away when the adriamycin was delivered in micropills Sears notes that the pills may be ready for people by 1984

—Caroline Rob

' Have courage for the great sorrows of life, and patience for the small ones And when you have accomplished your daily task, go to sleep in peace God is awake

—Victor Hugo

"There is no way of avoiding the advance of years except by dying and there is no great fun in that

—Isaac Asimov

Three Mile Island protesters The U S Court of Appeals has ruled that citizens nuclear fear must be carefully evaluated

FEAR POLLUTION

Is the anxiety experienced by people living near nuclear-power plants a serious health threat? Yes according to the U S Court of Appeals The court has recently ruled that the fear felt by those living near the Three Mile Island nuclear-power plant must be evaluated before the plant can be reactivated

It all started in March 1979, when panic-stricken residents near the malfunctioning plant in Pennsylvania formed People Against Nuclear Energy (PANE) PANE became especially incensed last year when the Nuclear Regulatory Commission (NRC) ordered the facility to start up again PANE asked the NRC to consider the awesome psychological impact of turning on the power But the commission refused arguing that technical, not emotional considerations were within its purview

PANE s attorney William Jordan, then petitioned the U S Court of Appeals He claimed that under the Atomic Energy Act of 1954 and the National Environmental Protection Act of 1969 the NRC must protect the public s health and safety, which includes social and psychological well-being We tend to think *environment* means birds and trees Jordan says ' But the National Environmental Protection Act is humanity-oriented meant to protect man's harmony with his environment At Three Mile Island that has been severely damaged

Early this year the court ruled that the NRC could not restart TMI 1 the twin of the damaged reactor, before assessing the effect on 'the psychological health of neighboring residents

—Sandra Dorr

OOPARTS

BY ROBERT PATTON

Did Egyptian pharaohs have airplanes? Did our ancient ancestors turn rock into plastic? Out-of-place artifacts offer some surprising clues

It was a classic out-of-place artifact or as archaeologists would say an oopart

While excavating an Egyptian tomb near Saqqara in 1891 investigators came upon a small birdlike object made of sycamore wood It was dubbed the Saqqara bird and, like the rest of the tomb's contents' dated to 200 B C Little more thought was given to the matter until almost 80 years later after the Wright brothers had made their landmark flight and ushered in the era of modern aviation To the next generation of Egyptologists the birdlike artifact looked uncannily like an airplane The resemblance was so striking that a team of aviation experts was assembled in the early Seventies to explore this hypothesis Their study revealed that the 5 6-inch-long body was aerodynamically sound In fact one aeronautics engineer noted a remarkable similarity between the Saqqara bird and a new oblique-winged aircraft that NASA planned to build And when the tiny wooden relic was subjected to the ultimate test—a flight trial—it soared through the air with the ease and grace of a modern-day glider To the experts the conclusion was inescapable The 2 000-year-old object was a model airplane

It is tempting to dismiss the Saqqara bird as an oddity a single misplaced piece in the incomplete mosaic of history But it is hardly alone among artifacts that demonstrate strikingly advanced ingenuity for their age Using increasingly refined tools for exploring the past archaeologists have identified a number of remnants that seem as improbable in their primitive context as cavemen donning Sony headphones Indeed the technical sophistication of certain age-old relics is so impressive that we have only recently come to understand

their purposes, prompting some scholars to wonder. Is it possible that the great scientific and technological achievements of the past 500 years were already known to ancient civilizations?

Consider

• Differential gears, which permit a machine to perform two functions simultaneously, were not used in the West until 1575. Yet this innovation was incorporated into the design of a model planetarium (shown on the preceding page) found on a salvaged ship that sank off the coast of Greece in 78 B.C.

• Electric batteries have been found in Iraq that date from 100 B.C.—more than 18 centuries before Ben Franklin received credit for discovering electricity.

• A map drawn in 1513 correctly depicts Antarctica's coastline *before* it was covered by ice—more than 6,000 years ago. Its accuracy could not be verified until 1949, when electronic probes were driven into the ice sheet covering the continent.

For years, scholars have puzzled over these and other ooparts—the acronym historian Rene Noorbergen coined for out-of-place artifacts. By all historical rights, ooparts simply should not exist. Until recently, these anachronistic objects were either relegated to the realm of the inexplicable or explained away as the mysterious residues of visiting spacemen.

Thanks to new techniques of dating, however, there has been much renewed interest in ooparts. Relics long abandoned to museum basements are being dusted off and their age accurately determined by such methods as thermoluminescence, neutron-activation analysis, X radiography, and radiocarbon dating. We have come a long way since 1650, when James Ussher, archbishop of Armagh, confidently declared that God created man in 4004 B.C.—a date that John Lightfoot, vice-chancellor of Cambridge University and a contemporary of Ussher's, further refined to 9 A.M. on October 23.

Because the so-called time curtain of man's history has been constantly pushed back, advances in chronology have conferred new respectability on the study of ooparts. Today the existence of such anomalies is no longer disputed. In fact, some academics are now suggesting that ooparts could be the key to antiquity's most intractable riddles.

Take the great megaliths that dot the world's landscape, from the pyramids of Egypt to the mighty statues of Easter Island to the vast circular structure of Stonehenge. These relics, many of them dating from the Stone Age, were once thought to be the work of a long-extinct race of giants. How could mere mortals build towering monuments out of stone blocks so heavy that a modern crane cannot lift them, and so precisely joined that a knife blade cannot fit between them? If a daring new proposal is correct, our early ancestors could turn rock into plastic.

At the International Symposium on Archaeometry, held at the Brookhaven National Laboratory in the summer of 1980, Joseph Davidovits revealed findings that stunned the distinguished audience. Davidovits, a scientist at the Geopolymer Institute in St.-Quentin, France, carried out an electrochemical analysis of stone fragments removed from the Gate of the Sun, this ten-ton, elaborately carved gate stands by itself on an isolated plateau at Tiahuanaco, Bolivia, 13,000 feet above sea level. The great mystery, of course, is how it got there.

The first clue Davidovits's investigation uncovered was that the molecular structure of the stone had been rearranged, suggesting that at one time it had existed in liquid form. Further analysis revealed traces of alkaline mineral reactants, such as oxalates, which are capable of dissolving stone. Davidovits hypothesizes that the original Huanka builders probably broke down the stone by chemical means at the rock quarry, transporting it in plastic form to the site of erection, where it would then be poured into a mold.

> *"Not until the 1930s, when commercial airlines first flew over the Andes, were the Nazca pictographs correctly recognized for what they clearly are."*

To support his contention, the scientist points out that present-day Huanka Indians still make stone objects in such a fashion. The oxalic acid, which they use to liquefy rock, is extracted from rhubarb leaves and other plants. The main question that remains unanswered is whether primitive people in other parts of the world could have possessed such knowledge. For instance, the giant stone heads of the Olmecs of central Mexico (see photo on page 52), their features curiously Negroid, date back to 1250–400 B.C. The faces were carved out of boulders weighing up to 24 tons, which are now known to have originated in a quarry 45 miles away. Plastic rock does not seem so farfetched when one contemplates the impossible task of dragging crushing loads over that distance with little more than crude sledges.

So far the Easter Island statues provide the only hint that this technology may have been widely known throughout the ancient world. Some of the carved stones at this site are four stories high and weigh up to 64 tons, all have been traced to a quarry five miles away. According to Davidovits, scrapings from these monuments contain an oxalic-acid residue. Were the inhabitants of Easter Island also skilled at melting down rock and molding it anew?

For the time being, Davidovits's theory remains just that. "It's intriguing, but definitely controversial," says Edward V. Sayre, a chemist at Brookhaven. Or at least that is his reserved judgment until Stonehenge, the Great Pyramid of Gizeh, and other megalithic wonders are put to the test.

As far as past scientific accomplishments are concerned, the truth is, we just don't know how much of man's accumulated wisdom has been lost through wars, natural disasters, and deliberate wholesale destruction. Isolated pockets of civilization may have flourished for centuries, only to be overrun by barbarians and their former glory lost forever. The oldest societies with a written record—Egypt, Mesopotamia, and the Indus Valley—seem to have emerged without any cultural antecedents, between 3400 and 3100 B.C. Seemingly out of nowhere, there suddenly appeared a uniform code of law, the wheel, knowledge of astronomy and agriculture, and elaborate temples inscribed with cuneiform or hieroglyphic script. Is it mere coincidence that three centers of enlightenment should emerge simultaneously at widely separated locations?

Some historians think these synchronistic events are the result of parallel development of unrelated cultures at similar stages of evolution. Others, however, adhere to the doctrine of diffusion—the fanning out of a culture from a central starting point. The unprecedented explosion of knowledge 5,000 years ago, they believe, may have been foreshadowed by an earlier society whose cultural remnants have long since vanished. The evidence for such a remote civilization, predating even the Sumerians, is tentative at best. But perhaps one vestige has persisted all these millennia—a remarkable map that a visiting Turkish naval officer presented to the U.S. Navy Hydrographic Office in 1956.

Charles H. Hapgood, a professor of the history of science at Keene State College in New Hampshire, was one of the first experts to scrutinize the artifact. It was a fragment of a world map drawn on a gazelle hide in 1513 by one Piri Reis, an admiral in the Turkish navy. On one corner of the document, Reis had written that the map had been compiled from some 20-odd older maps, one of them drawn by Christopher Columbus. Ever since Columbus's historic voyages to America, historians have been searching for the legendary chart that guided him. Here, it seemed, was evidence that such a map had once existed.

One aspect of the Piri Reis map especially caught Hapgood's attention. It seemed to chart correctly the coastline of Queen Maud's Land in Antarctica—a feat modern science had not been able to accomplish until 1949 because of the thick

ice sheet that covers the continent. Was the source map used by Piri Re'is drawn before the onslaught of the ice some 6,000 years ago?

Over the next few years Hapgood and a group of his students conducted an extensive study of the map. What they discovered came as a complete surprise to them.

• Comparing it with other portolans or port-to-port maps of the Middle Ages, they determined that all these maps seemed to be based on one original source map. Moreover, successive charts did not improve in accuracy. In other words, a map drawn at the beginning of the fourteenth century was just as good as one from the sixteenth century.

• According to computer analysis, that original source map had been drawn using plane trigonometry, prompting Hapgood to remark, "This was a total shock, since most experts believe there was no trigonometrical foundation to the portolan charts."

• The original cartographers used an oblong rather than a square grid, a type of projection that allows for the distortion created when a flat map is imposed on a sphere. Known as the Mercator projection, it is named for the man who supposedly invented it circa 1569, some 50 years after the Piri Re'is map was drawn.

• The Piri Re'is map correctly showed the contours of Antarctica before the ice sheet covered it. Hapgood's best estimate of when the original source map was drawn is 10,000 years ago.

The picture that seems to emerge, therefore," wrote Hapgood, "is of a scientific achievement far beyond the capacities of the navigators and mapmakers of the Renaissance, or of the known geographers of ancient times."

Others are not so sure. Derek de la Solla Price, Avalon Professor of the History of Science at Yale University, refuses to take Hapgood seriously. "I think he's gone way out on a limb," he said. "Scholarly life is difficult enough without stirring things up with far-out theories. I don't think his claims can be substantiated."

Nonetheless, Hapgood's findings have been accepted by the Cartographic Section of the U.S. Strategic Air Command and his methodology vouched for by the Rev. Daniel L. Linehan, director of the Weston Observatory at Boston College, and by Professor Francis J. Heyden, director of the Georgetown University Observatory.

The true story behind the Piri Re'is map may never be known. But it is certainly not the only artifact that has yielded previously unsuspected complexity upon scientific examination. Consider an object found in Iraq in 1936. It was excavated in Kajut Rabua, a farming village southeast of Baghdad, among ruins dated 250 B.C.–A.D. 650. It consists of a clay pot containing an inner cylinder of sheet copper with an iron rod suspended in the center. The edges of the copper cylinder appear to have been sol-

dered with a lead-tin alloy, and the iron rod seems to have been corroded by an acid solution long since evaporated. Other such pots have been found alongside thin iron and copper rods in Tel Omar, also near Baghdad.

"If you take all these things together," said Arne Eggebrecht, an Egyptologist with the Roemer und Pelizaeus Museum in Hildesheim, West Germany, who first saw these Iraqi pots in 1976, "to a scientist, they can only mean an electric cell."

To study these devices, Eggebrecht enlisted the aid of a battery specialist, an electrochemist, a goldsmith and a galvanizer. After making an exact replica of the Iraqi battery, they filled the model with an alkaline liquid made of the juice of freshly pressed grapes. The resulting current registered 0.5 to 2 volts of electricity.

Then Eggebrecht took a small silver statue, immersed it in a gold cyanide solution and passed electricity from his homemade battery through it. It took him less than two hours to apply a thin layer of gold to his statue. His team successfully repeated this experiment several times, proving, to their own satisfaction at least, that this could have been the means whereby ancient metalsmiths plated their jewelry.

"A half-volt to two volts of electricity is significant," comments Frank J. Biondi, former director of the Electronic Device Materials and Process Laboratories at Bell Labs and president of Bond Engineering. "The most frequently used battery in the modern world, the lead-acid battery, produces only two volts per cell. The proposal that a series of such cells were used to provide DC voltage and currents to electroplate gold is quite within the bounds of feasibility."

Early man may indeed have used electricity, but it should be noted that alternate methods of gilding precious objects were known in other parts of the ancient world. Archaeologists have uncovered hoards of buried artifacts in Peru, dating from the pre-Incan culture of the Chimu (circa 100 B.C.–A.D. 800), which at first glance appear to be electroplated. But according to Craig Morris, associate curator of the South American Collection of the American Museum of Natural History in New York, "They used a process known as depletion gilding. Essentially the process involves taking a metal alloy that has a small quantity of gold in it and removing all but the gold. Instead of adding gold to the surface. It's a fairly complicated, even an ingenious, process, but it does not involve electricity in any sense."

Another example of an artifact that could not be explained or properly analyzed at the time of its discovery is a mechanical contrivance found off the Greek island of Antikithera in 1900. Among the treasures of a Greek merchant ship that had foundered and sunk in the Aegean in 78 B.C. was an unlikely piece of bronze encased in wood and encrusted with centuries of calcareous or limestone deposits. The external wood casings cracked as the wood dried, and the enclosed bronze artifact was split into four flat fragments, the inner sides of which revealed parts of geared wheels with barely legible inscriptions. Scholars at the time initially identified the object as an astrolabe, a mechanical device used to determine the altitude of the sun and other celestial bodies.

There the matter rested until 1951, when Yale's Derek de la Solla Price studied the artifact and thought it much too complex to be a simple astrolabe. Even then Price was unable to say clearly what it was. Not until 1971, when gamma radiographs and X-radiographs were taken of the inner workings, was it revealed to be a geared planetarium. By means of dials and pointers, this intricate gadget could determine the motions of the sun and the moon, show where they were in the past and would be in the future and determine simultaneously the phases of the moon.

"If a daring new proposal is proved correct, the towering megalithic monuments of the ancient world were molded out of plastic rock."

Most amazing of all, the Antikythera mechanism possessed some 30 gears of various sizes and a differential gear shift that allowed two shafts to rotate at different speeds. Previously it had been the accepted wisdom of historians that no ancient civilization had either the knowledge or the inclination to build such complex machinery and that differential gears did not appear in the West until 1575.

Actually a mechanism similar to the Antikythera find had been described by Ovid in the third century B.C. It was ostensibly made by Archimedes, the great inventor and discoverer of the principle of specific gravity. Two centuries later Cicero described such an invention while residing in Rhodes, presumably about the time the Antikythera device was lost at sea.

"The Antikythera mechanism wasn't for calculation, not a computer in the modern sense," Price explains. "It was just a teaching model, its status more that of a planetarium than a computer. In my opinion—and so far no one has challenged my conclusions—it represents an important link in a continuous tradition that extended through the craft of clockwork in the Middle Ages, and culminated in the Industrial Revolution. It is the oldest existing relic of scientific technology."

Scientist and author Arthur C. Clarke puts it another way: "Unfortunately, this complex device merely described the planets' apparent movement; it did not help to *explain* them. If the insight of the Greeks had matched their ingenuity, the Industrial Revolution might have begun a thousand years before Columbus."

There is sometimes a reluctance among scientists to accept the authenticity of ooparts because so many major finds have been made by amateurs. One reason amateurs play such a large role, suggests Stuart D. Scott, Jr., professor of anthropology at the State University of New York in Buffalo, is that "a farmer working in a field, or another layman, is often the first to stumble upon a find. Only then is the discovery brought to the notice of the proper authorities."

Amateurs are quick to point out that their input has in many instances been beneficial, and they invariably cite the work of Alexander Marshack, a former journalist and drama critic. An *arriviste* in the world of science, Marshack correctly determined that 30,000-year-old bone tools found throughout Europe were crude attempts by primitive man to keep track of the phases of the moon. His insight—which he based on a hunch—has forced paleontologists to revise backward their estimate of when man first began to keep a systematic record of the heavens.

Then there is Barry Fell, a former professor of marine biology at Harvard University and a self-styled epigrapher who has translated inscriptions found on neolithic ruins in North America and interpreted them to mean that Europeans traveled to America 1,000 years before Columbus, that Libyans colonized Iowa in 500 B.C. and that Iberian Punic-speaking Celts settled in New England in 800 B.C. and left numerous dolmens (stone burial chambers) and other megalithic structures in their wake.

One of the most remarkable prehistoric documents deciphered by Fell was an engraved clay tablet, now called the Davenport Calendar Stele, found in an ancient burial mound near Davenport, Iowa, in 1874. It was noted at the time that this tablet was inscribed with what appeared to be three distinct scripts, but because no one could decipher them, scholars at Harvard and the Smithsonian Institution declared it to be a forgery.

The stele was then sent to the Davenport Academy of Sciences, later renamed the Putnam Museum, and was all but forgotten until nearly a century later when Barry Fell identified the inscriptions as Egyptian, Iberian Punic and Libyan. According to Fell, the stele appears to be a commemorative tablet celebrating the yearly festival of the Egyptian god Osiris and dates from around 700 B.C.

Fell's conclusions are by no means an

CONTINUED ON PAGE 104

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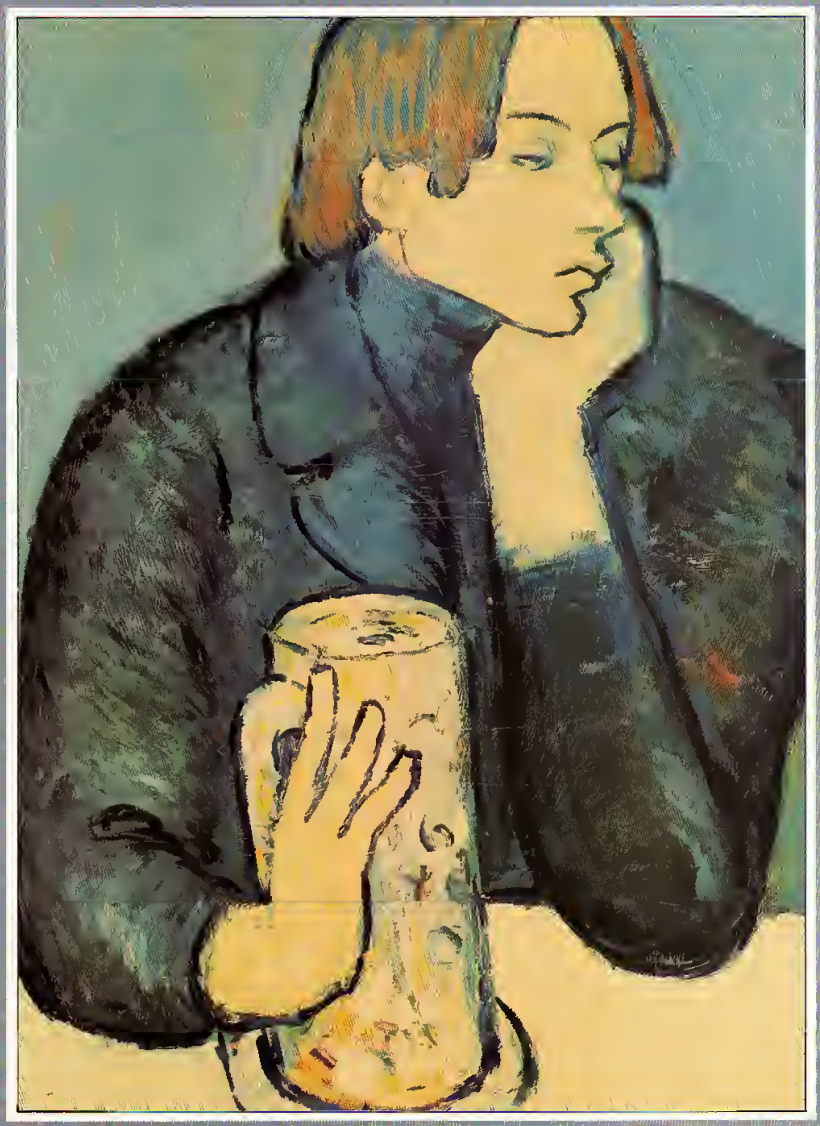

FICTION

THE MAN WHO MET PICASSO

A young artist is dazzled by a colorful riddle

BY MICHAEL SWANWICK

In another time, another place, the shop could have been a magician's lair. A gargoyle crouched, stone wings spread, above the shabby brownstone's doorway. Submerged within dark windows were cracked Tiffany shades and statuettes of Greek gods, lacking here an arm, there a head, that on the originals had survived into modern times. Weathered gilt lettering on the panes read FRANZ WEIL—RESTORATIONS.

Half a block away a gas station stood at the corner of an expressway feeder. Beyond it, air shimmered over the pavement. It mingled with exhaust fumes, was blasted apart by loud cars bright with hot chrome. Somewhere a burglar alarm warbled.

But inside, the shop was quiet, the traffic muted. Shadowed shelving reared over a nondescript desk and a few square yards of carpet. The vases and platters, cracked goblets and broken figurines might have been the slow limestone growths of a cave. An air conditioner in some distant part of the house took the edge off the heat, making it possible to keep the windows closed.

The old man positioned himself by the desk, reached a gnarled hand to the side, closed it about a circle of glass. He shuffled to the nearest window, where a solitary sunbeam pierced the interior gloom. It caught his white hair and suffused it with holy light.

The glass plate flashed purple fire as he held it up, turning it over and over again in his hands. "The fragments had to be baked together, or else, with the first little touch of tension, they would snap again." His voice was gentle and contemplative. "It's no great trick if you have the clamps to hold the pieces together perfectly.

PAINTING BY PABLO PICASSO

But they don't sell such things there's not the market You have to build them yourself you see?"

The customer nodded respectfully

Well put the glass down and started to turn, then stopped to pick up a Hummel figurine It was a fat boy with rouged cheeks he was playing an accordion "Look at this he said with mild disgust "People collect these things, you know Tell me Would *you* waste your time repairing a thing like this?"

The man smiled and shook his head

"That's good Time is precious It's the one limitation you can't ignore When I was young, I spent a *month* building a single set of clamps—imagine that! There was a statue with a broken bit of base—a nose—that I had to set perfectly But just as I finished the clamps, I saw some children playing in the mud I looked at them and put my work aside And I held that nose in place with a piece of putty

"Well, at least I had the skill I was a sculptor then Yes I was" He straightened slightly, to stare off into some nonexistent distance and his voice grew reminiscent. "How I wasted my youth! When I think of all I had—and I spent my life working on trash like this!"

Still the customer said nothing but it was an encouraging sort of silence and after a quick glance through his shaggy eyebrows Weil gestured the man to a chair

"It was so very long ago," he mused

It was an early autumn evening Paris was wet and miserable and I was on my way to the Opera This was a ridiculous expense for an art student—there were days when all I had to eat was one lousy apple—but my friend Marissa had received the tickets from her parents and had invited me along I remember that I had been working in granite that day and my hands were slightly red and tingled pleasantly

We were just chums Marissa and I, not lovers, and she was not a good-looking woman No, I lie—she was extremely beautiful But it was all internal to the eye she was quite ugly

We were walking along a drab and weary street—quickly for our coats were light—and the buildings were all huddled together and soaked with *tristesse* I was making some laughing comment when Marissa grabbed my arm and pointed across the street

"*Le Boeuf!*" she hissed We'd nicknamed Picasso the Bull because at that time he was painting all those pictures of minotaurs I looked and there he was Seated at a cafe table by the curb, hunched over a drink, with that little black beret of his slouched across his head

I shrugged "So?"

"This is your chance," she whispered urgently "Go up and ask him about the navel our teacher was telling us about

"You want me—a student, a nobody—to go up to *Le Boeuf* and ask him about one of his paintings?" I snorted "He wouldn't give me the time of day"

"You must go up and ask," she insisted fiercely

"No no I couldn't"

"Well if you won't then I *will*" And looking into those blazing green eyes I knew that she meant it My heart sank

"No don't do that He would only be rude to you He had a reputation for that kind of behavior Better that I go

"Then go!"

I waited a beat by the curb then darted between the cars to the other side Taking a deep breath I approached Picasso's table and stood across from him, not daring to speak before he noticed me

Slowly he raised his head lifted those baleful eyes to mine They glared with a malevolent light and his mouth moved like that of a camel

"*Idiote!*" he spat

I bowed politely and said in a low voice "*Oui, Maitre*" If the Master told me I was an idiot who was I to disagree?

> *"I looked, and there he was Seated at a café table by the curb, hunched over a drink, with that little black beret of his slouched across his head"*

"*Maître?*" he asked "You are one of us then? An artist?"

"*Un eleve*" I said "Only a student"

"Sit!" He pointed imperiously at the wire chair opposite him, and I obeyed He glanced at my rough callused hands "A sculptor eh?"

I admitted this was so and he looked pleased "You will have a drink with me

"Thank you *Maitre* but I—"

"*Garçon!*" He snapped his fingers and a waiter materialized He pointed at his glass "Another for my companion"

The waiter brought anisette a drink I had always loathed I took a sip trying not to grimace

For a moment he studied me silently A leaf fell to the table and he glanced at it deemed it unworthy, and swept it away "You have a girlfriend across the street?" he asked suddenly

Marissa was indeed standing where I'd left her clutching her light cloth coat about her and peering anxiously at us But Picasso was facing away from her he must have seen my glances "She is not exactly my girlfriend" I began

"Bring her over!"

Back across the street I ran to where Marissa stood shivering I took her hand and led her back She stood humbly before the great man and he looked her up and down with those basilisk eyes "You know" he said, "you are a remarkably ugly woman"

"*Oui, Maître*"

"Sit down!"

Picasso snapped his fingers for the waiter, then pointed to his glass again The man darted away "And yet—there is something about that chin Come by my studio next week and I will paint you"

"*Merci, Maître*"

"Bah!" he snorted in disgust Marissa's anisette arrived and she drank it with apparent pleasure Picasso turned to me again

"So Obviously you have a question or you would not have dared approach me Out with it!"

I stared into the milky liquid in my glass "You did a painting" I said hesitantly "some ten years ago of a woman—a nude It was called *La Belle*—"

"Bah! Do you have any idea how many women I have painted in my life? Hundreds! Thousands! And out of all these years you expect me to remember *one* painting?"

"She had an orange navel" I said The principal of our school had lectured us for a full day on that one painting

"Ahhh" Picasso said "I know the one you speak of What about it?"

"Our teacher the dean of our school, he said that the navel should not have been orange—that it should have been green"

Picasso's attention was absolute A truck smashed through a nearby puddle throwing up a rooster-tail of water that almost sprayed the table and he did not notice "And what did he say about my painting it orange?"

"He said that you were a fool"

"*Das Scheisskopf!*" The Master's face turned red and he began swearing in German an endless stream of truly foul words I wriggled in my chair in embarrassment

He noticed my reaction and stopped in mid-curse "So" he said "*Sie sprechen das deutsch*"

"*Ein klein plattdeutsch*" I admitted I was by no means fluent but I knew enough German to follow his outburst

"Well then you go back to your teacher and tell him he plays with himself"

"What!" I cried in astonishment Marissa's hand flew up to her mouth tried unsuccessfully to stifle a giggle

"Tell this pig that he plays with himself Tell him that *Picasso* says so"

I shook my head politely but firmly "You want me to tell the dean of my school this? No I am afraid not"

"Ahhh" he said "You are one of *those*" I had managed to choke down my anisette and he noticed that the glasses were empty gestured for refills I winced inwardly Picasso glared at me "And what do *you* think, eh?"

"I do not know why you painted it thus"

I said hesitantly "But I know that Picasso had a reason '

Oh? And how do you know that? There was something dangerous something very animal about the way he hunched forward over the table and I found myself tongue-tied unable to reply

Marissa silent until now said 'The painting has become almost an obsession with Franz we have discussed it again and again And he told me that you must have had a reason because he said Picasso is a wizard! '

Picasso rocked back in his chair bellowing with laughter "A wizard! That s good! So you think I am a wizard, eh my little sculptor?

' *Our Maître* I said humbly

"Then my young sorcerer s apprentice I must *be* your wizard eh? His eyes filled with dark demonic mirth 'But understand first of all that I do not speak about my work The paintings themselves must do the talking or else it is only words

He was silent for a moment but it was a compelling silence He was in control of it

'*But* he said at last "if you really wish to learn then I will tell you what to do Are you familiar with the works of El Greco?

'Yes certainly in reproductions

Reproductions—bah! Reproductions are nothing You cannot know a work until you have seen it But I'll tell you what You must go to the Prado

'Me? Go to Madrid? I was astonished all over again

'Yes To the Prado On the second floor you will find an El Greco called *Rooftops of Toledo* You go there and stand before it Look at it There is a vast spread of roofs all the city laid out under either a sunrise or a sunset Just off the center is one orange roof the only orange one among all the others Hold your thumb so that it covers that roof and no more You must study the painting see it as a whole Then *pull* your thumb away and you will have your answer

And for this I have only to go to the Prado? It was so ludicrous a suggestion that I had to struggle not to laugh aloud

'Yes that is your quest your wizard is sending you there

I shrugged 'I know you can tell by my accent that I am an American But you must understand that my family is poor and I am here on a scholarship Where would I come up with that kind of money?

He stared at me for a moment Then he took ouf a leather wallet ran a thumb through its contents calmly counted out five hundred francs, and gave them to me! "Take this he said 'and go Take her — he jerked his head at Marissa—'your girl friend with you Both of you do as I have directed ' The night was beginning to fall the street going dark We had missed the beginning-of our opera

Now I am not giving this to you If you go to Madrid and spend your time foolishly *you owe me this back* But if you do as I have instructed and return with the

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answer then you owe me nothing The money is yours And I will tell you why I painted the woman s navel orange '

I sat there, his money in my hand, not knowing what to say or do I opened my mouth shut it again

Picasso grew suddenly angry ' Go away!" he snapped "You are disturbing me—get out of here!"

So we went

It was an interesting trip Marissa costumed herself as an *haute-bourgeoise* and with a constant stream of demands and complaints made life miserable for the staff It got so that the porter would hunch his shoulders and try to bull his way past our compartment To no avail Marissa darted out fox stole swinging and seized the man's arm with her long red nails "My pillows!" she shrilled "They are *flat*!"

The man threw up his hands in dismay His little mustache drew in on itself "Madame—

"And the sandwiches in the luncheon car—the lettuce is quite definitely wilted!"

The porter could not edge away for Marissa still clung to his arm She leaned quite close to the poor man and with an air of final triumph added "And my lover—this morose young artist here—he is *lousy* in bed!" Then she released him

The porter fled down the corridor As soon as he was out of sight Marissa collapsed across her seat in laughter

I sat cracking my knuckles thinking of Picasso of all the money I owed

The Prado was all smooth marble floors and cold echoes We arrived early—I had not even allowed us time to freshen up—and the galleries were virtually deserted Now and then we'd hear twinned sets of heels click click by or a scattered fragment of light conversation It did not take us long to find *The Rooftops of Toledo*

Humbly like supplicants we stood before the work It was a grandiose sweep of roofs caught in the rich low-lying Spanish sun I could have eaten an apple in the time we stood there core seeds and all Then slowly hesitantly, I raised my thumb at arm's length until it just covered the orange roof near the center of the painting

Agonized minutes crept by My thumb wavered slightly but I held it stationary until my entire arm ached with fatigue poisons Cold sweat beaded on my forehead Still I didn't move And finally I *pulled* my thumb away triumphantly

And I saw—nothing

I almost collapsed The painting floated before me flat daubed with colors the speck of orange enigmatic and mocking Sweaty and pale I turned to Marissa to ask had *she* seen it

She shrugged—no Whatever this great secret was she had not seen it either nor did she especially care

That was Marissa She had shrewd intelligence, verve, and self-confidence and a cool discerning eye But she was only a *dilettante* a dabbler She had enrolled in the school because it was fashionable the thing to do There is no discredit to her in this—only she was not an artist She didn't care

But I had to care because to fail this test would be to admit that I also was no artist So again I tried only this time differently

You cannot actually *see* a painting unless it fills you I had been thinking of Picasso feeling the weight of his money and the fear of his disapproval All of this I forced myself to forget I stood and simply let the painting grow until it was all I saw and all I thought of Instead of seeking answers I waited

Marissa wandered away to look at other works but I did not notice Only dimly distantly was I aware of the slow passage of time of the still air the quiet Moving like a somnambulist, I raised my thumb held it steadily before me I studied the painting without demands or expectations

I snapped my thumb away And I *saw*

"Picasso's attention was absolute. A truck smashed through a nearby puddle, throwing up a rooster-tail of water that almost sprayed the table, and he did not notice."

I could have sobbed in relief The museum gallery seemed to swim about me I turned to Marissa saw that she was not there that she was several paintings away and hurried to her side

Do you want to try again? Look harder this time " I said

'No,' she said She looked at me oddly " You have the most idiotic grin on your face

I realized suddenly that my cheeks hurt But what did I care? I grabbed Marissa swung her around kissed her right there in the middle of the Prado!

Events kept me from reporting back to Picasso immediately on my return But one bright October morning found me on the Rue des Grands-Augustins where his studio was The seventeenth-century mansion houses along the street had been subdivided into offices and businesses a little worn but not quite shabby Balzac had lumbered ponderously down this very way a walrus touched by divine fire and I followed in his footsteps The day was unseasonably warm so bright and fine that I almost forgot my troubles

At number 7 I plunged within and hurried up a gloomy spiral stairway I took the steps two and three at a time past a process server's office up to a simple door on which was tacked a hand-written note *C'est ici!* it said Here it is I knocked

For a moment nothing Then the door flew open and Picasso stood before me wearing a striped sailor shirt and white duck pants He carried a mop under one arm and in the hand of that same arm held a galvanized steel bucket of whitewash

'Herr Weil ' he said threateningly I was flattered that he had remembered my name "Come in!"

Flooded with cool, northern light the studio was a vast and colorful pigsty Frayed chairs were half-buried under piles of tin cans pegboards burlap and steel rods Canvas flats leaned against walls brightened by here a Matisse there a Rousseau And everywhere of course were his own canvases but they were placed facing walls not to be seen

'You have interrupted me in the middle of my work" Picasso said steering me around a pile of newspapers and paint-pots out of which poked an old rusting bicycle "Stand *there*—and do not make a sound until I am done"

He planted me beside a broken-seated cane chair on which rested several canvases a Modigliani peeking out from the rear I almost caught my ankle in a snarl of wire when I realized that I was standing on one of the Master's sketches and frantically I hopped away I steadied myself with one hand on a paint-flecked ladder and watched him work

One wall of the studio was all plate glass with clear autumn light streaming through Beyond I could see the tail end of a line of brick rowhouses with tiny, walled-in yards and a cemetery The sky was as flatly blue as that of any Miro and the graveyard with its orchardlike lines of small white tombstones was all grass gone brown

Picasso was painting goats on the window He dipped the mop into the bucket of whitewash then smoothly, surely painted directly onto the glass as if the mop were a gigantic brush I stood entranced

Those goats! The man had an uncanny a perfect knowledge of animal anatomy The goats gamboled joyfully on the glass and though they were drawn with broad strokes almost as cartoons every detail was perfect In a continuous sweep he drew a head continuing the line to include the bump on the back the upswelling behind the cranium

The mop danced across the glass creating ritual making these creatures of the spring into something sacred something that could not be expressed in words alone

Finally he was done He stepped back to study the work and without looking at me said ' What do you think?"

I kissed my fingertips "*C'est magnifique!* You are truly a great artist"

" No" he snarled ' I want your honest opinion Don't try to flatter me '

There was some small movement in the cemetery beyond the glass but I could not look past those luminous spritely goats.

"No opinion was ever more honest," I said. "You are magnificent, a great artist—truly a wizard!"

Grasping a large sponge he advanced menacingly on the window. "It is not good enough for *Picasso*," he said and wiped it all clean.

I could have cried to see first one goat, then another, disappear in ugly white smears. The Master worked vigorously, attacking the glass until it was all clean. I could look beyond now and see the tiny figures on the dying grass gathered about a small hole in the ground, a funeral.

Picasso threw the sponge away and turned on me. "You have been to the Prado otherwise you would not dare show your stupid face before me. And now you *think* you have seen what I instructed you to see, eh? Well—I am waiting."

I faced him squarely. He could not bully me. I knew what I had seen. "I have done as you told me, *Maître*, and I have two observations."

"Eh! I send you to see one thing, and you come back with *two*," he sneered.

"The first thing I saw was that it was not a sunrise, but a sunset."

"That is so," he said impatiently. "And the other?"

"The second thing I saw was that the orange roof spreads the color of the setting sun about the rooftops, so that the eye sees its warmth on them all, even though there is not a touch of orange paint on any of the others."

"Exactly!" he cried. "*That* was what I sent you to see. El Greco had set himself a problem. He wanted to show the rich glow of sunset on the roofs, but without daubing pigment on each and every roof. He wanted to do it in the most economical fashion possible. It is a *trompe l'oeil*, a trick of the eye. The orange roof spreads its glow, but only in the eye of the viewer—not on the canvas itself. It supports the others without touching them."

"And *that* is why I painted the woman's navel orange. That painting had given me a lot of trouble: the stomach and limbs were too angular, too flat, and I wanted them to be rounded—soft. But I did not want to ring in the third dimension. That is *your* province, my young sculptor. It is not the painter's."

"Painting is merely design. It is flat. To bring in the third dimension is to cheat. But still I wanted that illusion of roundness."

"It was a problem that I thought about for weeks—at the easel, in the cafes, on the crapper. Until I finally remembered El Greco, and painted her navel not green but orange."

"The orange you see spreads its glow across her belly and breasts, her arms and legs—and the eye is tricked into seeing them as rounded and soft. Yes, I broke the rules—but knowingly. For that is the artist's chore—to first master the rules and then overcome them. The rules exist, but they can all be circumvented."

He fixed those cold eyes on me. "And there is the gist of it. The actual painting is nothing; it is dead. It is only the working out of problems that the artist sets for himself that matters. The learning." Behind him the coffin was being lowered into the cold earth.

"You—you will be an artist. You have the eye for it. But you must learn to never stop learning. Discipline—sure you need discipline, you must work constantly every minute of every day. But that is something you pick up along the way. Even you already have that kind of discipline, eh?"

I reddened and muttered, "*Oui, Maître*." It was true.

"You have called me a great artist—I do not believe there is such a thing. You have called me a wizard. Well," he smiled oddly, "perhaps I am. But first and foremost—pay attention to me now—I am a Student now and for the rest of my life."

"I almost caught my ankle in a snarl of wire when I realized that I was standing on one of the Master's sketches, and frantically I hopped away. I steadied myself nervously."

I fell back a pace from the intensity of his harangue. The Master came after me, grabbed my collar and said, "Now recite back to me what you have learned, my apprentice sorcerer."

"First, about the roof," I said. "It supports without touching."

Picasso released his grip. "Hah! Good—your artist's eye sees right to the core of it. Yes, it is very much like the artist in that sense: aloof yet supporting all, lending color and meaning to the world. Go on."

"Next, that the rules exist to be learned and then overcome. Outside the prayers were done and dirt was being shoveled into the grave."

He almost smiled. "One more."

"That one never ceases to learn."

"That an *artist* never ceases to learn," he corrected. "All very good. But you came back with only two observations, and I have given you three answers. How shall we correct this imbalance, eh?"

"I—"

"I have it! You will go out now—today! You will make a bust of your girlfriend, the ugly one, and you will return with it to me within a week. If it is good, I will see that it is sold. If not—" He made a gesture with his hands, as if balling up and discarding a scrap of paper.

The joy I had been feeling all died at once. Rather than face the Master, I stared out at the funeral, which was slowly beginning to break up. "I am sorry, *Maître*, but I cannot."

Picasso was outraged. "You say no to *me*?" He grabbed the mop from the floor, hurled it away to crash noisily against a stack of corrugated iron sheeting.

"I am sorrier than words can say, *Maître*. But I have just received a telegram from home, and—" I fished the piece of paper from my pocket, and he snatched it out of my hand.

His face sour, Picasso read the telegram aloud. "'Come home. Your father is dying.' " He threw it on the floor in disgust.

"All the preparations have been made," I said. "I leave in the morning."

"Shall I tell you what will happen?" he asked. He took me by the shoulders, turned me to face the funeral party. "First of all, you will go home and your father will die. Never doubt it—fathers die."

He pointed at the small black figures. "That woman—*there*—the one apart from the others, like an old carrion crow. She is your mother. She will take you aside as soon as the funeral is over."

The woman was joined by another small speck, from this distance it could as well have been me as anyone else.

"She will say to you, 'There's me, and the five children. And there's you. While he was alive, your father took care of us. Now it's your turn.'"

Perhaps the two were talking; it was impossible to tell. I saw the woman place an arm around the other's shoulder.

"And you will say, 'You mean—my career? It's over?' " His voice became mocking, whiny and he shook me ferociously as he predicted these words.

"And do you know what she will say then, this mother of yours? She will say, 'It's a tough world.' " He flung me away from him. His eyes were savage. "Haven't you heard a single God-damned *word* of what I've told you?"

Turning my back on the funeral, I gave him a small bow and headed for the door. "I'm sorry, *Maître*."

"Then go!" he screamed. "Pass by your chance to be a sorcerer. What do I care? But you have wasted my time, and in the final reckoning that sin will weigh heaviest against you!"

He slammed the door behind me.

The old man sighed. "Ah, well," he said, "what did I know? The Master was a prophet. The conversation went almost word for word as he said it would. And then came the war, and then I married and raised a family. They are all gone now, vanished like smoke. I tell myself that when I retire I will return to sculpting. But I know that I won't. I'll never retire."

The man said nothing.

CONTINUED ON PAGE 93

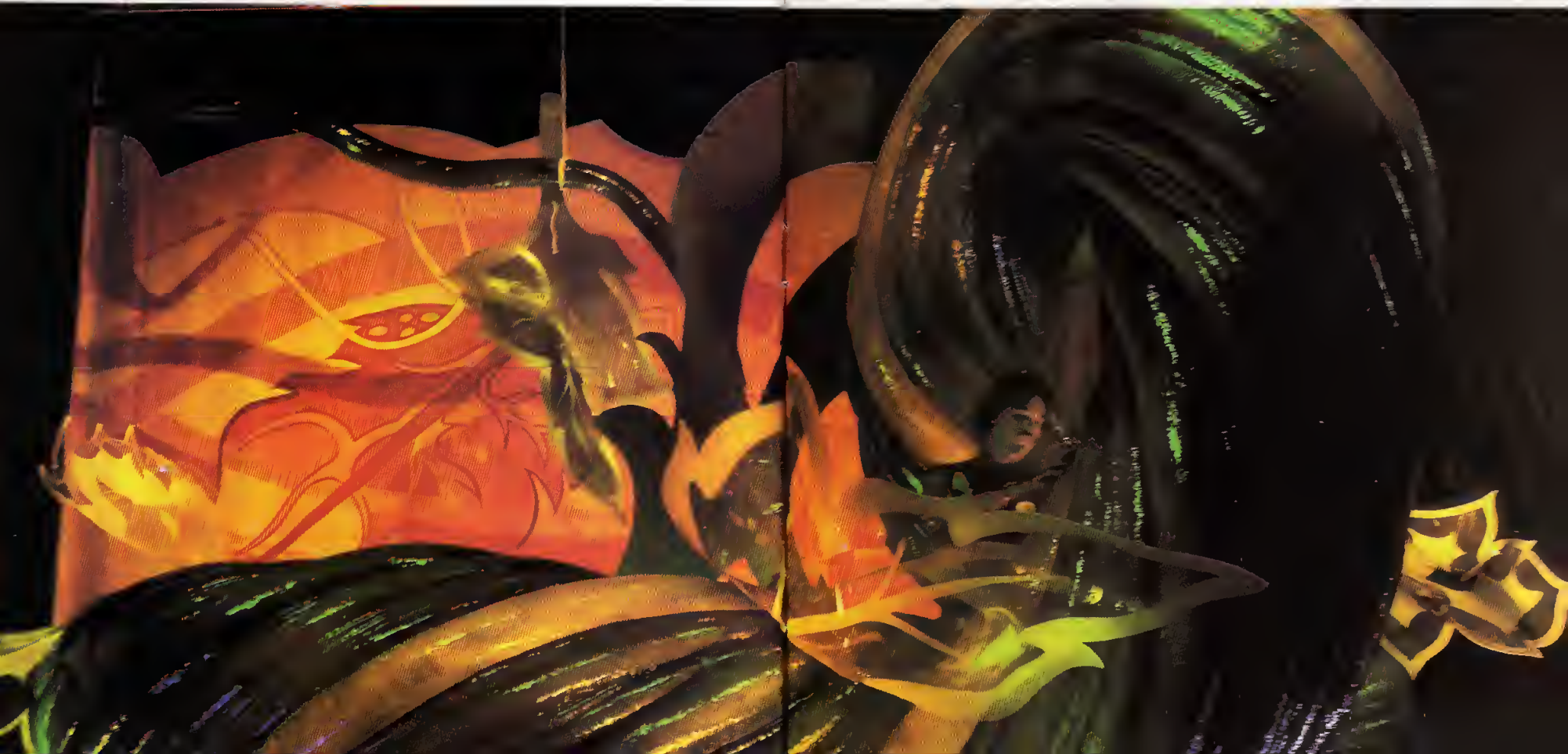
Mickey Mouse has seen the future—and has made it work

TOMORROW LANDS

BY TIM ONOSKO

It has been on the drawing boards for 15 years, comes with a price tag of close to $1 billion, and was Walt Disney's last and some say grandest dream. It is called EPCOT (Experimental Prototype Community of Tomorrow) Center. Part amusement park, part world's fair, it will be at the very least the playground of tomorrow and one of the riskiest entertainment ventures ever

PHOTOGRAPHS BY BRIAN WOLFF



Now rising from 550 acres of Florida swampland inside the mammoth piece of real estate known as Walt Disney World EPCOT is easy to find It is just a quick 2 5-mile monorail ride from Cinderella s Castle in Disney World s Magic Kingdom park a short hop to the future

Unlike other Disney theme parks EPCOT Center will not greet its visitors with Minnie and Mickey ambling down Main Street There will be no magic castles no souvenir shops laden with Disneyana People looking for Adventureland instead will find pavilions where animated shows (like the volcano shown on the previous page) tell the story of the search for new energy resources Instead of Frontierland they will come upon a cavernous pavilion full of almost surreal displays and shows telling how man has used the land to obtain his daily bread (large photo on the opening pages depicting the life cycle of a plant) Those hoping for a trip through Fantasyland will instead be asked to take a trip guided by their own imaginations And there won't be any need for Tomorrowland The whole place is Tomorrowland

EPCOT Center is the future or rather a collection of ideas about the future in the Disney idiom It is due to open this October 1 when Disney promotion boasts "the 21st Century begins " Despite the Walt Disney Productions trademark the success of EPCOT is by no means assured Many new and largely untested talents have worked on it And, judging from a preliminary glimpse of what has been done some of their ideas are richly imaginative fascinating extensions of the Disney style Other ideas, though may disappoint those who travel to EPCOT Center looking for a stirring vision of the future

What Walt Disney Productions is building on its Disney World property near Orlando is a permanent exhibit—a "showcase of ideas " describes the promotional jargon As any visitor will soon discover the showcase will be in the form of two complexes clustered on either side of a man-made lagoon On the far side is the World Showcase a collection of U S and foreign villages exhibiting the various countries manufactured products, foods, and ideas On the near side near the entrance to the center, is Future World a grouping of theme pavilions that house displays games, and educational shows about such broad topics as energy land use transportation and communications Future World promises to be the more dazzling half making liberal use of technologies like holography, touch and talk television screens and laser-light shows as well as the famous Disney androids offically known as Audio-Animatronics figures (Disney people prefer that to the less technical-sounding "robot ")

The complex is the first giant step in the direction of realizing an idea Walt Disney made public shortly before his death in 1966 In one 20-minute film he talked briefly about EPCOT "I don't believe there's a challenge anywhere in the world that's more important to people everywhere than finding solutions to the problems in our cities But where do we begin?" he asked "Well we're convinced that we must start with the public need And the need is not just for curing the old ills of old cities We think the need is for starting from scratch on virgin land and building a special kind of new community Our Experimental Prototype Community of Tomorrow will always be in a state of becoming It will never cease to be a blueprint of the future where people actually live a life they can't find anywhere else today "

Years later the details of that blueprint were to be worked out at WED (for Walter *Elias Disney*) Enterprises the Disney Corporation think tank Located a few miles from the Disney Studios in an industrial neighborhood of Glendale California WED is in an anonymous unassuming single-story building that looks as it it might just as well house a furniture factory or a prosperous metal-fabrication shop

"When Walt Disney unexpectedly died, he left his associates with two things: a 27,500-acre parcel of land in Florida and an undeveloped idea for EPCOT."

It was founded in 1952 to create Disney land and was staffed with ex-film animators who followed their master from films to his park projects Today it is a closely guarded dream factory where creative professionals—artists and engineers whom Disney dubbed his "imagineers"—discuss art architecture, and philosophy in the lingo of corporatese that business dialect that likes to describe projects as doable or audiences as "up-scale "

For the past four or five years the 2 000 WED imagineers have been working on two projects a new Disneyland for Tokyo and EPCOT Center which Disney people claim is the largest private construction project in the United States WED people plan *everything* from the layout of EPCOT to the design of the buildings to the transportation systems that will be used which is why WED is sometimes described as the factory that builds cities

John Hench, senior vice-president in the WED organization is one of EPCOT s chief planners Like many Disney veterans he knew Walt personally (virtually everyone in the organization refers to its founder by his first name) from the days when he was an artist and later an art director on such Disney feature-length cartoons as *Fantasia*, *Peter Pan* and *Alice in Wonderland* Now in his mid-seventies, Hench recalls the first time Walt came to him and broke the news about EPCOT "

"I was in my office and Walt walked by and put his hand on my shoulder—that was unusual—and just said How would you like to work on the city of the future? Walt was very careful in his dealings with everybody—particularly financial people—not wanting to scare them too much He took them step by step I compare it to films EPCOT was his Scene Fifty-five his big grabber He didn't see why he should give you that first He kept the idea until he was ready "

The problem is Walt may have kept the idea too much to himself When he unexpectedly died he left his associates with two things a 27 500-acre parcel of Florida swampland and an undeveloped idea for EPCOT That legacy constituted a deathbed challenge to his staff

The first thing they did was build Disney World In its design they incorporated dozens of new approaches and new technologies valuable for solving urban problems Cars are restricted in Disney World Visitors for the most part leave their vehicles in a parking lot and travel through the park by Disney transportation buses ferries and an efficient monorail system All its infrastructure is underneath Magic Kingdom in a cavernous basement A sophisticated fire-defection system is coordinated from a computerized center All of its accommodations are designed maintained, and totally controlled by the Disney Corporation

To prepare for all this the Disney Corporation asked for and was given by the state of Florida what amounted to an almost sovereign quasi-governmental control of its land As a result, Disney World became a state within a state even dictating its own development and building codes It also became a major source of income for the Disney Corporation In fact both theme parks Disneyland (in California) and Disney World have been big money-makers for the company producing more than three times the movie revenues for 1981

Today Disney World has everything it needs to function as a community Was it designed with the intention of becoming one someday? Walt Disney had intended that his EPCOT concept would be realized on the parcel of land now called Disney World As late as 1973 the Disney Corporation still quoted Walt as saying that EPCOT would be a real city where "people actually live a life they can t find elsewhere in the world today

Also after Walt s death his brother Roy had more detailed plans drawn up from Walt's sketchy notes What the EPCOT town would have looked like can be seen in the renderings It was a circular city with a 30-story motel and other commercial build-

ings at its hub and residential living zones beyond the center set in a series of concentric circles. Radiating from the center like the spokes of a wheel was a series of people-mover tracks designed to carry the community's population of 20,000.

Who would have lived there? Presumably, EPCOT's citizens would have been idealists attracted to the place by the promise of a foretaste of future life. By necessity they probably would have been hand-picked by the Disney Corporation. They could have become a kind of permanent test market, where industries could try out new products before taking them to the world at large.

That was the dream of 16 years ago. Now Disney people are not so sure it is one they can make work. For one thing, if it were some sort of living test tube where various ideas and technologies were tried out, it would also be a place of constant change. "Imagine what it would be like if, every six months, an EPCOT plumber came to your door and ripped out your kitchen because it was obsolete," one ex-Disney staffer suggests. "And there would be all those people coming around peering into your home." For another, today such an idea sounds too much like social experimentation, and Walt had never worked out how such an artificially constructed complex would be made a true community.

So EPCOT has become a concept that Disney's successors have decided to reinterpret. The EPCOT that will open this fall will have no permanent residents. The company has adopted the line that the tens of thousands of daily visitors to the Florida Disney complex will be its residents. And it is no longer thought of as a community where people live. The Disney organization now asks us to think of it as "a community of ideas." It is now carefully renamed, not just EPCOT, but EPCOT Center.

Did Walt Disney really want a city of his own?

"It's really hard to say," answers Marty Sklar, vice-president of creative development at WED and one of Hench's closest associates, "because he never really went beyond the first scene."

"I really don't think Walt would have established a community right now," Hench adds. "Walt Disney World—the whole thing is really all EPCOT. If we had built the ultimate community, no matter what it is—Arcosanti or whatever—I think people aren't ready for this."

If there is some doubt as to what EPCOT should be, there is none about why it is being built. "It's because of Walt," Sklar admits. Beyond that, leisure industry analysts surmise there is some other, more corporate strategy. In recent years attendance at Disney World has leveled off, in part because the baby boom that fueled the big park attendances of the 1960s and 1970s is over. And those babies are now adults in their twenties and thirties. Designed as an educational, more sophisticated theme park, EPCOT Center is seen

by some as a way of appealing to that adult audience and increasing Disney World attendance. Disney executives are projecting that EPCOT Center will draw 8 million to 10 million more people annually to their Florida theme-park complex.

What will the visitors find when they arrive? Visually, the style of the place might be called exposition, or world's fair, architecture. It even has a giant ball (in this case a geodesic sphere) as its centerpiece. Buildings are clean-lined structures of bold geometric shapes, a sort of standard futuristic architecture.

In the tradition of many world's fairs, the opening scene of EPCOT will be its 180-foot-tall geodesic sphere. Inside, its visitors will ride in tunnel-of-love type cars on a spiraling journey through Spaceship Earth, a robot show that depicts the history of man's communication, beginning with cave-wall painting and concluding with a satellite flight into space.

The sphere's exit leads directly to a crossroads area called Earth Station, part of CommuniCore (for community core), which will function as an information center and gateway to other areas.

The future will be depicted within CommuniCore as "achievable and doable," according to Pat Scanlon, director of research and futures planning for WED. "People are scared enough of the future with everything that's happening," says Scanlon. "We don't want to put them into a future with people in aluminum jump suits. This is the near-term future, the day after tomorrow."

Scanlon's concerns aside, CommuniCore will strongly remind visitors that the project speaks in the future tense. In CommuniCore's Earth Station, overhead motion-picture screens and a big-screen video projector will show both prerecorded and live views of attractions and activities in the park. Here, foreigners who do not speak English can obtain earphones and a receiver for EPCOT's simultaneous-translation system, beamed to each user via infrared light.

Also in CommuniCore, visitors can obtain information about EPCOT via video display terminals designed by Bell Labs. Each terminal will have a touch-sensitive video screen. On it will be displayed a menu of information. To find out more, all one need do is touch the screen next to an item. Instant information will appear. The last item on the menu is one word: HELP. Anyone who touches that is put in immediate two-way video contact with an EPCOT host or hostess who has been trained to answer any questions or evaluate and then take care of emergency situations.

American Express will also use an interactive video system in its CommuniCore offices, providing viewers a choice of "surrogate travel experiences." Touch the screen at the country or place of your choice, and you are shown a quick travelogue of that area. CommuniCore, with all its state-of-the-art hardware and bustling, sleekly designed setting, makes for a distinctly futuristic scene.

"The crossroads within CommuniCore lead to the Futureworld pavilions, each of which is a collection of robot shows, films, participatory games and demonstrations."

The largest of these is The Land, gathering six acres of exhibits under one roof. Its focal point is something called "Listen to the Land," in which visitors will cruise along in a carefully paced boat ride past a series of theatrical settings showing the microlife of a seed, from germination to growth, and the varying geographic features of the United States, from swamps to prairies to deserts. Unfortunately, the plant life is fake. Although convincing in appearance, the trees are plaster and the leaves plastic. The big feature of this exhibit is an experimental future farm designed by Dr. Carl Hodges, director of the University of Arizona's Environmental Research Laboratory. Visitors will see vegetables and fruits moved through a feeding area on conveyor belts. Lettuce and tomato plants will be seen growing in hydroponic gardens. In another part of the pavilion is a robot show, "Kitchen Kabaret," a musical revue in which giant animated foods will sing specially written songs about good nutrition.

> *"People are scared enough about tomorrow. We don't want to put them into a future with people in aluminum jump suits. This is the near-term future, the day after tomorrow."*

In the Universe of Energy pavilion, Disney androids act out the familiar tale of the primeval world and tell the story of the origin of fossil fuels. Elsewhere in the pavilion, Disney acknowledges alternate energy sources—geothermal, solar and wind—but in this show the necessity for the continued use of nuclear-power plants during this century is emphasized. The key message, according to WED's Randy Bright, the chief planner of the energy shows, is that world energy needs must be met by a multitude of sources, not just petroleum.

EPCOT's Transportation pavilion, named World of Motion, may be the most reminiscent of world's-fair presentations, and it concentrates principally on the history of transportation. Sponsored by General Motors, it heavily emphasizes the automobile and the life-style that relies on it. One previewed theme song: "It's Fun to Be Free."

Unlike other Disney projects, these shows, though coordinated at WED, were not all designed by the same people. The scale of the operation required that different creative teams work on different pavilions to finish them on schedule. The result was a wide divergence in the sophistication of the numerous presentations.

CommuniCore's central show (sponsored by Sperry), for example, is in the computer complex that controls nearly all of EPCOT's exhibit areas and shows and that manages the heating and cooling systems. The problem with computers as entertainment potential, according to Hench, is that "they're about as lively as a coin-operated laundry."

Yet any discussion of the future would be incomplete without paying homage to the role of computers. WED designers were stuck with the problem of how to make this big chunk of hardware the star of their show. Unfortunately, the solution may not earn passing marks.

Writer Tom Fitzgerald decided to build the computer show around a host. Incomprehensibly, it is a Cockney street musician (on leave from World Showcase's United Kingdom pavilion) who marvels at the computer's tough tasks and reminds spectators that computers do good things in your hometown too. The theme of the show is an upbeat show tune, "The Computer Song."

Fitzgerald says that designers quickly scrapped the idea of actually explaining how computers work. The show never really addresses the question of what computers are and never discusses how they can prove beneficial. So instead of easing the fear that many people have of computers, My Friend, the Computer will probably leave them whistling a tune but as bewildered as when they walked in. Children will probably be the most disappointed and yearn to return to their classroom full of Apples.

By contrast, there is the Kodak-sponsored pavilion, Journey into Imagination. Its chief designers, Tony Baxter and Barry Braverman, have created a theatrical parable of the processes of the imagination, featuring two characters, a Wizard of Oz–like professorial type named Dreamfinder and his fanciful creation, a tiny lavender dragon named Figment. A living cartoon, its style is sheer Disney, but its content is a thoughtful dissection of human creativity, done to great effect.

In Image Works, the pavilion's participative area, Braverman and Baxter have assembled games and activities that should render every existing electronic arcade obsolete. Magic Palette is a video-graphics system equipped with an electronic paintbrush and a control surface and 26-inch video screen on which players can paint by using special wands and a touch-sensitive palette of electronic colors. In the Electronic Philharmonic, a hand breaking into beams of light switches on music and creates a fantasy symphony.

Finally, Imagination offers a giant screen

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An aerial view of the electronic highways and byways that crisscross

MICROCHIP CITIES

BY ROBERT MALONE

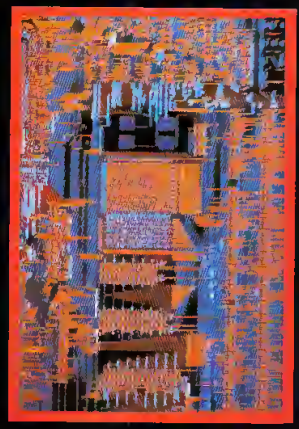
The subject of Phillip Harrington's photographic studies can be dislodged by a vigorous sneeze. A renowned specialist in photomicrography, Harrington has fixed his camera on wafers of silicon less than one eighth of an inch in thickness. That miracle of modern technology—the computer-on-a-chip—is barely discernible to the human eye. But when seen through the lens of a microscope, its intri-

PHOTOGRAPHS BY
PHILLIP A. HARRINGTON

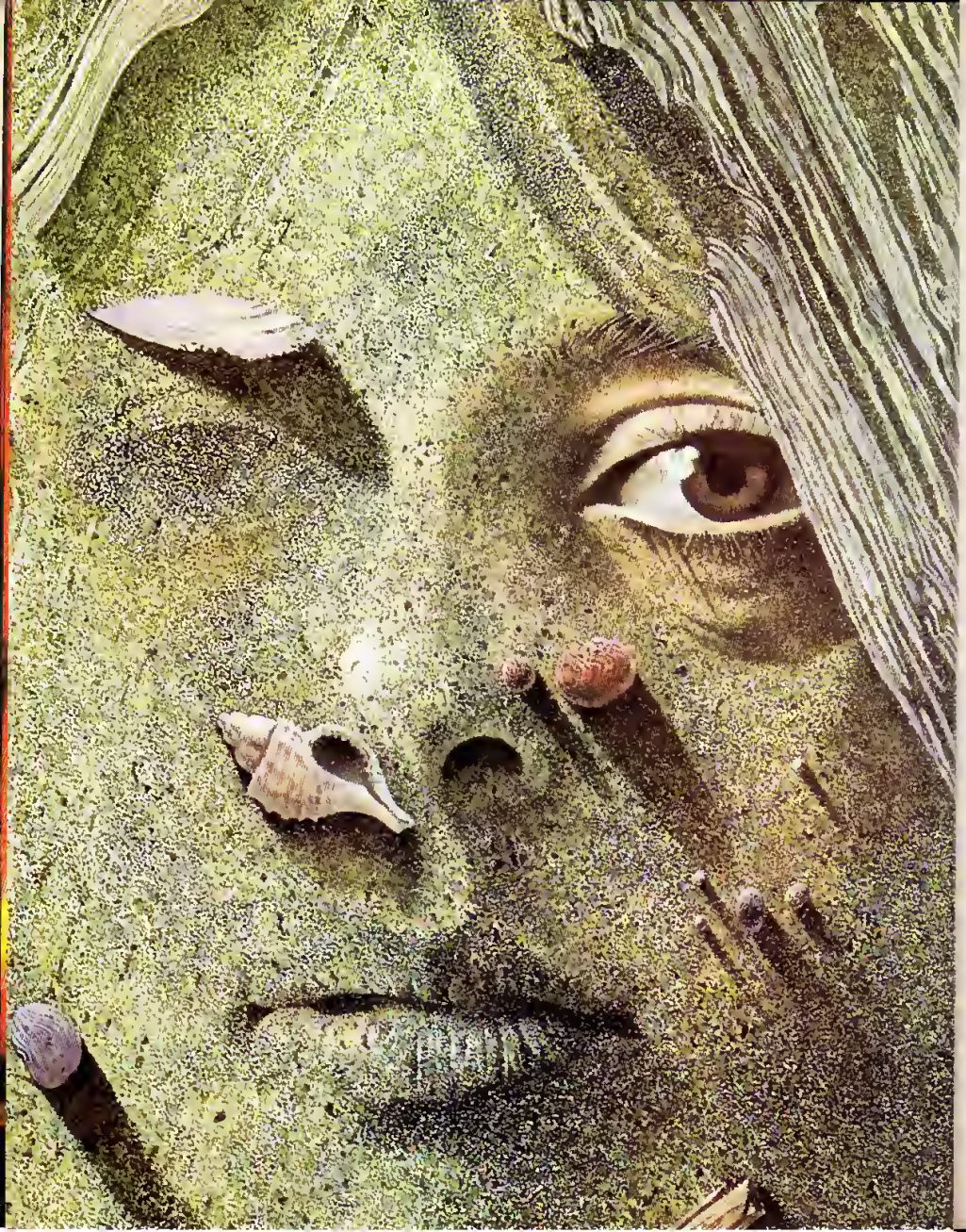
"Harrington's photographs of microchips could be taken for urban landscapes."

cate circuitry forms a maze of intersecting paths that makes a map of New York City's subway system look simple by comparison. There is nothing Harrington likes to do better than explore the electronic tunnels, avenues, and side streets of his silicon cities. Under a low-power magnifying lens, the entire urban landscape comes into view. At a medium range of resolution, Harrington focuses on blocks in the gridlike network. At still higher powers of magnification, he can make out the terraced roofs and plazas of his imaginary buildings. Of course, what he is actually seeing is computer gates, chip-testing hardware, pieces of ROMs (built-in memory), RAMs (temporary memory-storage banks), and CPUs (central processing units). "If you run your finger along the surface of a chip, you can feel the multilayered texture of the electronic components," Harrington explains. To capture their architectural detail on film, however, is no easy feat. Among other things, the silicon coating on chips acts like varnish, producing a troublesome sheen

"A complex lighting system is used to accent the chip's multilayered structure."



To overcome such technical problems, Harrington brings a battery of tools to his trade. His Olympus research microscope uses a twin-lighting system to accent textural gradations. The chip can be illuminated from below, which creates the silhouettelike effect of an opaque body on a light box. Or it can be flooded with light from above, as if placed under a street lamp. Sometimes Harrington also mounts fiber-optic bundles onto the stage of the microscope. When aimed like miniature spotlights, they can be used to highlight specific portions of circuitry. Color filters placed in front of any of these light sources add drama to the composition. Or, as Harrington puts it, "They create a shimmer along the edge of the chip, and the sense of depth that emerges is truly remarkable." In fact, when observing chips at the highest power of magnification, he occasionally experiences a dizzying sensation: "You feel as if you were pushed off a skyscraper and are falling into a void . . . entering a world of infinity . . . a world made of dreams." ∞



FICTION

EYES I DARE NOT MEET IN DREAMS

A boy, trapped in a prison of silence, unconsciously gives a special gift to a grieving husband

BY DAN SIMMONS

Bremen left the hospital and his dying wife and drove east to the sea. The roads were thick with Philadelphians fleeing the city for the weekend, and Bremen had to concentrate on traffic, leaving only the most tenuous of touches in his wife's mind.

Gail was sleeping. Her dreams were fitful and drug-induced. She was seeking her mother through endlessly interlinked rooms filled with Victorian furniture.

As Bremen crossed the pine barrens, the images of the dreams slid between the evening shadows of reality. Gail awoke just as Bremen was leaving the parkway. For a few seconds after she awoke the pain was not with her. She opened her eyes, and the evening sunlight falling across the blue blanket made her think—for only a moment—that it was morning on the farm. Her thoughts reached out for her husband just as the pain and dizziness struck behind her left eye.

Bremen grimaced and dropped the coin he was handing to the toll-booth attendant.

"What's the matter, buddy?"

Bremen shook his head, fumbled out a dollar, and thrust it blindly at the man. Throwing his change in the Triumph's cluttered console, he concentrated on pushing the car's speed to its limit. Gail's pain faded, but her confusion washed over him in a wave of nausea.

She quickly gained control despite the shifting curtains of fear that fluttered at the tightly held mindshield. She subvocalized, concentrating on narrowing the spectrum to a simulacrum of her voice.

"Hi, Jerry."

"Hi, youself, kiddo." He sent the thought as he turned onto the exit for Long Beach Island. He shared the visual—the startling green of grass and pine trees overlaid with the gold of August light, the sports car's shadow leaping along the curve of asphalt. Suddenly the unmistakable saltfreshness of the Atlantic came to him, and he shared that with her also.

The entrance to the seaside community was disappointing: dilapidated seafood restaurants, overpriced cinderblock motels, endless marinas. But it was reassuring in its familiarity to both of them, and Bremen concentrated on seeing all of it. Gail began to relax and appreciate the ride. Her presence was so real that Bremen caught himself turning to speak aloud to her. The pang of regret and embarrassment was sent before he could stifle it.

PAINTING BY ALAN MAGEE

The island was cluttered with families unpacking station wagons and carrying late dinners to the beach. Bremen drove north to Barnegat Light. He glanced to his right and caught a glimpse of some fishermen standing along the surf, their shadows intersecting the white lines of breakers.

Monet, thought Gail, and Bremen nodded, although he had actually been thinking of Euclid.

Always the mathematician, thought Gail, and then her voice faded as the pain rose. Half-formed sentences shredded like clouds in a gale.

Bremen left the Triumph parked near the lighthouse and walked through the low dunes to the beach. He threw down the tattered blanket that they had carried so many times to just this spot. There was a group of children running along the surf. A girl of about nine, all long white legs in a suit two years too small, pranced on the wet sand in an intricate, unconscious choreography with the sea.

The light was fading between the Venetian blinds. A nurse smelling of cigarettes and stale talcum powder came in to change the IV bottle and take a pulse. The intercom in the hall continued to make loud, imperative announcements, but it was difficult to understand them through the growing haze of pain. The new doctor arrived about ten o'clock, but Gail's attention was riveted on the nurse who carried the blessed needle. The cotton swab on her arm was a delightful preliminary to the promised surcease of pain behind her eyes. The doctor was saying something.

"... your husband? I thought he would be staying the night."

"Right here, doctor," said Gail. She patted the blanket and the sand.

Bremen pulled on his nylon windbreaker against the chill of the night. The stars were occluded by a high cloud layer that allowed only a few to show through. Far out to sea, an improbably long oil tanker, its lights blazing, moved along the horizon. The windows of the beach homes behind Bremen cast yellow rectangles on the dunes.

The smell of steak being grilled came to him on the breeze. Bremen tried to remember whether he had eaten that day or not. He considered going back to the convenience store near the lighthouse to get a sandwich but remembered an old Payday candy bar in his jacket pocket and contented himself with chewing on the rock-hard wedge of peanuts.

Footsteps continued to echo in the hall. It sounded as if entire armies were on the march. The rush of footsteps, clatter of trays and vague chatter of voices reminded Gail of lying in bed as a child and listening to her parents' parties downstairs.

Remember the party where we met? thought Bremen.

Chuck Gilpen had insisted that Bremen go along. Bremen had never had much use for parties. He was lousy at small talk and the psychic tension and neurobabble always left him with a headache from maintaining his mindshield tightly for hours. Besides, it was his first week teaching graduate tensor calculus and he knew that he should be home boning up on basic principles. But he had gone. Gilpen's nagging and the fear of being labeled a social misfit in his new academic community had brought Bremen to the Drexel Hill townhouse. The music was palpable half a block away, and had he driven there by himself he would have gone home then. He was just inside the door—someone had pressed a drink in his hand—when suddenly he sensed another mindshield quite near him. He had put out a gentle probe, and immediately the force of Gail's thoughts swept across him like a searchlight.

Both were stunned. Their first reaction had been to raise their mindshields and roll up like frightened armadillos. Each soon found that useless against the unconscious probes of the other. Neither had ever encountered another telepath of more than

> *Suddenly, almost without volition, they flooded each other's mind with a torrent of images, self-images, secrets, sensations, echoes, and feelings. Nothing was held back.*

primitive, untapped ability. Each had assumed that he or she was a freak—unique and unassailable. Now they stood naked before each other in an empty place. Suddenly, almost without volition, they flooded each other's mind with a torrent of images, self-images, half-memories, secrets, sensations, preferences, perceptions, hidden fears, echoes and feelings. Nothing was held back. Every petty cruelty committed, sexual shame experienced, and prejudice harbored poured out along with thoughts of past birthday parties, ex-lovers, parents and an endless stream of trivia. Rarely had two people known each other as well after fifty years of marriage. A few minutes later they met for the first time.

The beacon from Barnegat Light passed over Bremen's head every twenty-four seconds. There were more lights burning out at sea now than along the dark line of beach. The wind came up after midnight, and Bremen wrapped the blanket around himself tightly. Gail had refused the needle when the nurse had last made her rounds, but her mindtouch was still clouded. Bremen forced the contact through sheer strength of will. Gail had always been afraid of the dark. Many had been the times during their six years of marriage that he reached out in the night with his mind or arm to reassure her. Now she was the frightened little girl again, left alone upstairs in the big old house on Burlingame Avenue. There were things in the darkness beneath her bed.

Bremen reached through her confusion and pain and shared the sound of the sea with her. He told her stories about the antics of Gernisavien, their calico cat. He lay in the hollow of the sand to match his body with hers. Slowly she began to relax, to surrender her thoughts to his. She even managed to doze a few times, and her dreams were the movement of stars between clouds and the sharp smell of the Atlantic. Bremen described the week's work at the farm—the subtle beauty of his Fourier equations across the chalkboard in his study and the sunlit satisfaction of planting a peach tree by the front drive. He shared memories of their ski trip to Aspen and the sudden shock of a searchlight reaching in to the beach from an unseen ship out at sea. He shared what little poetry he had memorized, but the words kept sliding into images and feelings.

The night drew on, and Bremen shared the cold clarity of it with his wife, adding to each image the warm overlay of his love. He shared trivia and hopes for the future. From seventy-five miles away he reached out and touched her hand with his. When he drifted off to sleep for only a few minutes, he sent her his dreams.

Gail died just before the false light of dawn touched the sky.

The head of the mathematics department at Haverford urged Bremen to take a leave or a full sabbatical if he needed it. Bremen thanked him and resigned.

Dorothy Parks in the psychology department spent a long evening explaining the mechanics of grief to Bremen. "You have to understand, Jeremy," she said, "that moving is a common mistake made by people who have just suffered a serious loss. You may think that a new environment will help you forget, but it just postpones the inevitable confrontation with grief."

Bremen listened attentively and eventually nodded his agreement. The next day he put the farm up for sale, sold the Triumph to his mechanic on Conestoga Road and took the bus to the airport. Once there, he went to the United Airlines counter and bought a ticket for the next departing flight.

For a year Bremen worked in central Florida, loading produce at a shipping center near Tampa. The next year Bremen did not work at all. He fished his way north from the Everglades to the Chatfooga River in northern Georgia. In March he was arrested as a vagrant in Charleston, South Carolina. In May he spent two weeks in Washington, during which he left his room only to go to liquor stores and the Congressional Library. He was robbed and badly beaten outside of the Baltimore bus

station at 2 AM on a June night. Leaving the hospital the next day, he returned to the bus station and headed north to visit his sister in New York. His sister and her husband insisted that he stay several weeks, but he left early on the third morning, propping a note up against the salt shaker on the kitchen table. In Philadelphia he sat in Penn Station and read the help wanted ads. His progress was as predictable as the elegant ellipsoid mathematics of a yo-yo's path.

Robby was sixteen, weighed one hundred seventy-five pounds, and had been blind, deaf, and retarded since birth. His mother's drug addiction during pregnancy and a placental malfunction had shut off Robby's senses as surely as a sinking ship condemns compartment after compartment to the sea by the shutting of watertight doors.

Robby's eyes were the sunken, darkened caverns of the irrevocably blind. The pupils, barely visible under drooping, mismatched lids, tracked separately in random movements. The boy's lips were loose and blubbery; his teeth gapped and carious. At sixteen, he already had the dark down of a mustache on his upper lip. His black hair stood out in violent tufts, and his eyebrows met above the bridge of his broad nose.

The child's obese body was balanced precariously on grub-white emaciated legs. Robby had learned how to walk at age eleven but still would stagger only a few paces before toppling over. He moved in a series of pigeon-toed lurches, pudgy arms pulled as tight as broken wings, wrists cocked at an improbable angle, fingers separate and extended. Like so many of the retarded blind, his favorite motion was a perpetual rocking with his hand fanning above his sunken eyes as if to cast shadows into the pit of darkness.

He did not speak. His only sounds were occasional meaningless giggles and a rare squeal of protest which sounded like nothing so much as an operatic falsetto.

Robby had been coming to the Chelton Day School for the Blind for six years. His life before that was unknown. He had been discovered by a social worker visiting Robby's mother in connection with a court-ordered methadone-treatment program. The door to the apartment had been left open, and the social worker heard noises. The boy had been sealed into the bathroom by the nailing of a piece of plywood over the bottom half of the door. There were wet papers on the tile floor, but Robby was naked and smeared with his own excrement. A tap had been left on, and water filled the room to the depth of an inch or two. The boy was rolling fitfully in the mess and making mewling noises.

Robby was hospitalized for four months, spent five weeks in the county home, and was then returned to the custody of his mother. In accordance with further court orders, he was dutifully bused to Chelton Day School for five hours of treatment a day, six days a week. He made the daily trip in darkness and silence.

Robby's future was as flat and featureless as a line extending nowhere, holding no hope of intersection.

Shit, Jer, you're going to have to watch after the kid tomorrow.

'Why me?'

'Because he won't go into the goddamn pool, that's why. You saw him today. Smitty just lowered his legs into the water, and the kid started swinging and screaming. Sounded like a bunch of cats had started up. Dr. Whilden says he stays back tomorrow. She says that the van is too hot for him to stay in. Just keep him company in the room till Jan McLellan's regular aide gets back from vacation.'

'Great,' said Bremen. He pulled his sweat-plastered shirt away from his skin. He had been hired to drive the school van, and now he was helping to feed, dress, and babysit the poor bastards. 'Great. That's just great. Bill. What am I supposed to do with him for an hour and a half while you guys are at the pool?'

'Watch him. Try to get him to work on the zipper book. You ever see that page in there with the bra stuff—the eyes and hooks? Let him work on that. I use to practice on that with my eyes shut.'

'Great,' said Bremen. He closed his eyes against the glare of the sun.

Bremen sat on the front stoop and poured the last of the scotch into his glass. It was long past midnight, but the narrow street teemed with children playing. Two black teen-agers were playing the dozens while their friends urged them on. A group of little girls jumped double Dutch under the streetlamp. Insects milled in the light and seemed to dance to the girls' singing. Adults sat on the steps of identical rowhouses and watched one another dully. No one moved much. It was very hot.

It's time to move on.

Bremen knew that he had stayed too long. Seven weeks working at the day school had been too much. He was getting curious. And he was beginning to ask questions about the kids.

Boston perhaps. Farther north. Maine.

Asking questions and getting answers. Jan McLellan had told him about Robby. She had told him about the bruises on Robby's body, about the broken arm two years before. She told him about the teddy bear that a candy striper had given the blind boy. It had been the first positive stimulus to evoke an emotion from Robby. He had kept the bear in his arms for weeks. Refused to go to X-ray without it. Then, a few days after his return home, Robby got into the van one morning, screaming and whining in his weird way. No teddy bear. Dr. Whilden called his mother only to be told that the God-damned toy was lost. "God-damned toy" were the mother's words, according to Jan McLellan. No other teddy bear would do. Robby carried on for three weeks.

So what? What can I do?

Bremen knew what he could do. He had known for weeks. He shook his head and took another drink, adding to the already-thickened mindshield that separated him from the senseless, pain-giving world.

Hell, it'd be better for Robby if I didn't try it.

A breeze came up. Bremen could hear the screams from a lot down the street where two allied gangs played a fierce game of pick-up ball. Curtains billowed out open windows. Somewhere a siren sounded faded. The breeze lifted papers from the gutter and ruffled the dresses of the girls jumping rope.

Bremen tried to imagine a lifetime with no sight, no sound.

Fuck it! He picked up the empty bottle and went upstairs despondently.

> *"The sudden surge of background babble was abrasive. It was like coming into a bright room after months in a cave. He tuned out the neurobabble and looked into Robby's mind."*

The van pulled up the circular drive of the day school, and Bremen helped unload the children with a slow care born of practice, affection, and a throbbing headache.

Scotty emerged, smiling, hands extended to the unseen adult he trusted to be waiting. Tommy Pierson lurched out with knees together and hands pulled up to his chest. Bremen had to catch him or the frail boy would have fallen face first into the pavement. Teresa jumped down with her usual gleeful cries, imparting inexact but slobberingly enthusiastic kisses on everyone who touched her.

Robby remained seated after the others had exited. It took both Bremen and Smitty to get the boy out of the van. Robby did not resist; he was simply a mass of pliable but unresponsive fat. The boy's head tilted back in a disturbing way. His tongue lolled first from one corner of the slack mouth and then from the other. The short, pigeon-toed steps had to be coaxed out of him one at a time. Only the familiarity of the short walk to the classroom kept Robby moving at all.

The morning seemed to last forever. It rained before lunch, and for a while it looked

as if the swimming would be canceled. Then the sun came out and illuminated the flowerbeds on the front lawn. Bremen watched sunlight dance off the moistened petals of Turk's prize roses and listened to the roar of the lawnmower. He realized that it was going to happen.

After lunch he helped them prepare for departure. The boys needed help getting into their suits, and it saddened Bremen to see pubic hair and a man's penis on the body of someone with a seven-year-old's mind. Tommy would always start masturbating idly until Bremen touched his arm and helped him with the elastic of the suit.

Then they were gone, and the hall, which had been filled with squealing children and laughing adults, was silent. Bremen watched the blue and white van disappear slowly down the drive. Then he turned back to the classroom.

Robby showed no awareness that Bremen had entered the room. The boy looked absurd dressed in a striped green top and orange shorts that were too tight to button. Bremen thought of a broken, bronze Buddha he had seen once near Osaka. What if this child harbored some deep wisdom born of his long seclusion from the world?

Robby stirred, farted loudly, and resumed his slumped position.

Bremen sighed and pulled up a chair. It was too small. His knees stuck into the air, and he felt ridiculous. He grinned to himself. He would leave that night. Take a bus north. Hitchhike. It would be cooler in the country.

This would not take long. He need not even establish full contact. A one-way mindtouch. It was possible. A few minutes. He could look out the window for Robby, look at a picture book, perhaps put a record on and share the music. What would the boy make of these new impressions? A gift before leaving. Anonymous. Share nothing else. Better not to send any images of Robby either. All right.

Bremen lowered his mindshield. Immediately he flinched and raised it again. It had been a long time since he had allowed himself to be so vulnerable. The thick, woolly blanket of the mindshield, thickened even further by alcohol, had become natural to him. The sudden surge of background babble—he thought of it as white noise—was abrasive. It was like coming into a glaringly bright room after spending months in a cave. He directed his attention to Robby and lowered his barriers again. He tuned out the neurobabble and looked deeply into Robby's mind.

Nothing.

For a confused second Bremen thought that he had lost the focus of his power. Then he concentrated and was able to pick out the dull, sexual broodings of Turk out in the garden and the preoccupied fragments of Dr. Whilden's thoughts as she settled herself into her Mercedes and checked her stockings for runs. The receptionist was reading a novel—*The Plague Dogs*. Bremen read a few lines with her. It frustrated him that her eyes scanned so slowly. His mouth filled with the syrupy taste of her cherry cough drop.

Bremen stared intensely at Robby. The boy was breathing asthmatically. His tongue was visible and heavily coated. Stray bits of food remained on his lips and cheeks. Bremen narrowed his probe, strengthened it, focused it like a beam of coherent light.

Nothing.

No. Wait. There was—what?—an *absence* of something. There was a hole in the field of mindbabble where Robby's thoughts should have been. Bremen realized that he was confronting the strongest mindshield he had ever encountered. Even Gail had not been able to concentrate a barrier of that incredible tightness. For a second Bremen was deeply impressed, even shaken, and then he realized the cause of it. Robby's mind was damaged. Entire segments were probably inactive. With so few senses to rely on and such limited awareness, it was little wonder that the boy's consciousness—what there was of it—had turned inward. What at first seemed to Bremen to be a powerful mindshield was nothing more than a tight ball of introspection going beyond autism. Robby was truly alone.

Bremen was still shaken enough to pause a minute and take a few deep breaths. When he resumed, it was with even more care, feeling along the negative boundaries of the mindshield like a man groping along a rough wall in the dark. Somewhere there had to be an opening.

There was. Not an opening so much as a soft spot—a resilience set amidst the

CONTINUED ON PAGE 100

At a National Cancer Institute lab, researchers separate components of animal blood (above) and process batches of antibodies (right) in research to capitalize on natural defenses against cancer

CLONES VS. CANCER

BY OWEN DAVIES

Within a decade, cells spawned in labs may provide the treatment of choice

PHOTOGRAPHS BY DAN McCOY

Even a vampire settles for mere blood. Physicians at Boston's Sidney Farber Cancer Institute take the very marrow. But for children dying of leukemia, temporarily losing their blood-forming cells could be the best thing that ever happened to them. Removing their marrow is the first step in a startlingly effective new treatment for this fatal illness.

Traditional cancer treatments rely on radiation or harsh drugs to kill tumor cells. Most can be nearly as hard on the patient as on the cancer. The new procedures are based on antibodies, which are natural weapons the body uses to ward off illness.

Antibodies are the Sherlock Holmes of our defensive system. Whenever some foreign material enters the body—in an infection, say, or a transplant—antibodies ferret out the alien substances, called antigens. Then Scotland Yard, in the form of white blood cells and a material called complement, comes along to help finish them off. In the last five years or so, researchers have learned to arm antibodies against specific cancers. And they've discovered inexpensive ways to make copies—clones—of [illegible] antibodies. Doctors call them monoclonal antibodies because the clones spring from a single (mono-) kind of cell. Many scientists think that these tiny, purebred, seemingly single-minded antibodies can put an end to the terror of cancer, possibly within the next ten years.

"What we do in leukemia is take out some of the patient's bone marrow and destroy the rest with radiation,"

explains Dr. Stuart Schlossman, head of the Boston project. Ordinarily this would kill the patient within a week because the marrow is the body's source of blood cells. But Dr. Schlossman's team treats the extracted marrow with complement and monoclonal antibodies that destroy the cancer yet leave normal cells unharmed. Then doctors inject this marrow back into the patient. "When it works," Schlossman says, "this leaves the patient free of cancer cells—cured."

The key to this technique is to find the right antibody to attack the leukemia, then produce it in large amounts. It isn't easy. If antibodies are the immune system's Holmes, cancers are its Professor Moriarty, the villain too clever to be caught. Either tumor cells closely resemble healthy ones, or they exude some protective chemical that prevents the body from reacting to them. Other illnesses stimulate antibody production, but frequently cancer—even as a large, malignant lump—does not. Or when it does, the antibody concentration is too low to lock on to all of the intruder. So doctors have long sought a way to manufacture pure antibody in large amounts—to amplify the human body's own weak defenses.

For a solution, researchers turned to a venerable laboratory ally, the white mouse. The procedure is almost cookbook simple. Scientists inject a bit of the human cancerous tumor into a mouse, whose system will react to any human cells as foreign. A day later the mouse is churning out antibodies as fast as it can. But it secretes tens of thousands or hundreds of thousands of different antibodies. A few combat the tumor. Most would attack the patient's normal tissue as well, if they were injected into the human. And the mouse produces too little antibody to cure even one patient.

So experimenters collect the antibody-producing cells from the mouse's spleen and fuse them with cells from a mouse cancer. Unlike normal tissue, cancers grow wildly in the body or in the lab; this is what makes them so destructive. The hybrid cells produced by uniting spleen and tumor cells still secrete pure antibodies. Each cell's output is different. And because each cell is half-cancer, its descendants can be grown forever in laboratory flasks.

All that remains then is to screen each cell to find one whose antibody will attack the tumor in the human patient but not normal tissue. A suitable cell can be mass-produced—cloned—as needed, and its antibody can be purified to get rid of contaminants from the mouse cancer that might themselves cause cancer in humans or—far more likely—an allergic reaction. The result is monoclonal antibody.

"Those are the big advantages: specificity and the unlimited quantity," says Dr. Jeffrey Schlom of the National Cancer Institute (NCI). "People tried for decades to use natural mixtures of antibodies against cancer, and it never worked well. The key is to find the *right* antibody. Once you have it, making more is trivial. You just grow the cells. The amount of antibody you need to locate a tumor costs maybe a dollar. The drug companies are just going bananas."

Turned against leukemia, the antibodies developed at Farber have been spectacularly successful. Out of seven patients treated, only one has relapsed; the others have remained cancer-free for up to 18 months. In wide-scale use, antileukemia antibodies could save some 14,000 lives a year in the United States alone. And success to date is just a hint of what may come from antibody-based cancer therapies. Among the most important developments:

• One sixty-seven-year-old man seen at Stanford University suffered from a tumor that attacks antibody-producing cells. As recently as a year ago he would not have survived. To cure him, Dr. Ronald Levy of the Stanford University Medical School, hatched an ingenious scheme. Like the cells from which it sprang, the cancer still produced antibodies. So Dr. Levy made a mouse antibody to attack the tumor cell antibody, figuring that it would go straight to the tumor itself. Both standard cancer-fighting drugs and interferon had failed to halt the man's cancer. The monoclonal antibody stopped it cold.

• A test for several important cancers has been developed by researchers at Philadelphia's Wistar Institute. The team has discovered a protein that seems to appear only in the blood of patients with pancreatic or colorectal cancer (of the colon or rectum). Monoclonal antibodies attach themselves to this protein even when it is present only in tiny quantities. By tracking the antibodies, doctors reveal not only the protein in the bloodstream but also the tumors, and with fantastic efficiency.

• Antibody-based scanners are allowing doctors to see tumors too small to appear on normal X rays. Labeled with radioactive atoms, monoclonal antibodies can zero in on a cancer within minutes, outlining it brightly on the screen of a computerized radiation detector—much like a CAT scanner—already used in major hospitals. According to Dr. Karl Erik Hellstrom of Seattle's Fred Hutchinson Cancer Center, the technique can show hidden tumors only half an inch across.

• Ferritin, a protein found in normal cells, is produced by many tumors in large quantities. In normal tissue it aids in the use of iron; no one knows what it does for cancer cells. But in work by Dr. Stanley Order and his colleagues at Johns Hopkins School of Medicine, antibodies to it have shown signs of attacking cancers of the liver, lungs, and other organs.

Some of the most promising work with monoclonals has come in the field of lung cancer. "A truly usable antibody for lung carcinoma would be extremely valuable," notes Dr. Ingegerd Hellstrom, an immunologist who works with her husband, Karl, at Seattle's Hutchinson Center and holds

"Inventing the umbrella doesn't seem to have improved anything."

a position as associate professor of medicine at the University of Washington. "There is so little to offer today."

A treatment for breast cancer is still far off, according to Dr. Schlom. But valuable diagnostic tests may already be here. "One very important use that's unique to breast cancer is a technique called lymphangeography," he says. "When a woman has a breast removed, the pathologist examines the lymph nodes near the armpit to find out whether she needs chemotherapy. If there is no sign of cancer in these nodes, the woman is sent home. Yet about a third of the women who are told they have no further tumor cells soon relapse.

"The trouble is that there is another set of lymph nodes under the chest wall. No one looks at them because that would require major surgery. We can use isotope-labeled antibody to examine these nodes and perhaps catch tumors there."

But the real glamour in the antibody field is the hope that augmenting the patient's immune response will yield the cure for cancer. According to Dr. Order, there is good reason to hope. "We have tested antiferritin in twenty-five patients with a liver cancer so severe that half of all patients are dead three months after it is diagnosed," he says. "It takes nine months just to complete the treatment, and eleven patients who have done so show no sign of cancer. Antiferritin has also stopped Hodgkins disease and one form of lung cancer in four out of the five patients we've treated."

Another ingenious technique may also help prevent the rejection of transplanted organs. As a last resort in leukemia, doctors have often tried to replace the patient's bone marrow with normal marrow from a healthy donor. In most organ transplants, the body rejects the foreign tissue. But the transplanted marrow itself carries some of the equipment that does the rejecting, so in this case the transplant attacks its new body. The result is an often fatal illness known as graft-versus-host disease (GVH).

Dr. John Hansen, also of the Hutchinson Center, has prepared monoclonal antibodies against "T cells," the part of the marrow that attacks the host. Dr. Hansen used the preparation on patients whose GVH had already held out against the usual drug treatments designed to facilitate transplants. The antibody managed to halt the illness in 3 out of 12 patients. It wasn't a dramatic success. Hansen concedes, but it was enough to encourage further research. And there were no side effects.

Natural antibodies kill foreign cells both by attacking the cell wall directly and by calling in white blood cells that devour the invader. Researchers think they can make artificial antibodies far more lethal. Almost any poison that can be bound to antibodies, including the standard cancer drugs and radioisotopes, can be guided into tumor cells. One promising new candidate is ricin, a protein found in castor beans. Soviet secret police used it in London four years ago to eliminate a Bulgarian defector named Georgi Markov, Farber's Dr. Schlossman points out.

Researchers at the University of Texas Southwestern Health Center have already shown just how potent ricin-tagged antibodies can be. Working with mice, they have been testing a leukemia treatment similar to that used by Schlossman and his colleagues. The animals' marrow is removed, dosed with antibodies, and returned after a radiation treatment. But instead of using antibodies and complement, they are testing ricin-loaded antibodies. "The leukemia we use is extremely lethal," says Dr. Ellen Vitetta at the Dallas Center. "Yet about eighty-five percent of our test animals are permanently cured."

Before antibody-based treatments can be practical, some problems have to be solved. Antibodies now in use are made from mouse-spleen cells. After a few weeks of therapy, the patient's immune system recognizes the mouse protein as foreign and destroys the antibodies before they can attack the tumor. Scientists are now working to make antibodies from human cells. "An easier way might be to switch animals," says Johns Hopkins's Stanley Order. "When the patient rejects mouse antibodies, go to rabbits or goats."

> *"Cancer-fighting drugs and interferon had failed to halt the man's cancer. The antibody stopped it cold. Nine months after treatment, the patient was still free of the disease."*

Another problem: It can be very difficult to find the right antigens to attack. Most antigens appear on normal cells as well as cancers. Stanford's Dr. Levy estimates that it takes six months to develop an antibody for use against cancer, and the process must be repeated for each patient.

Other researchers put their estimates far higher. Searching for antibodies that can be used against small-cell carcinoma of the lung, Dr. John Minna and colleagues at NCI screened about 20,000 antibodies, only 1 in 250 was worth a close look.

"I think the main problem is that many tumors are not uniform," says NCI's Dr. Schlom. "As the mass grows, many different types of cells appear. Some carry a given antigen, others right next to them do not. This is not true of leukemias or lymphomas, but for solid tumors it means that we may have to use several antibodies at once to get a cure." According to some recent experiments, killing only one or two of the cell types in a tumor may cause the others to grow rapidly.

And Dr. Karl Hellstrom points out that "probably no antigen is unique to tumors. They are simply much more abundant on the tumor cell. This is usually an important difference. If cancer cells are vastly more sensitive to a normal drug than healthy tissue is, doctors can dose the tumor fatally while leaving normal cells unharmed. With such potent toxins as ricin-loaded antibodies, however, *any* of the antigen on normal cells may attract a fatal dose of the poison, creating a situation comparable to death by "friendly fire."

"The question is whether ricin-carrying antibodies will kill even cells with just a few antigen molecules and whether that causes trouble," Hellstrom says. "If they attack a cell that is common and not essential, that may not be a problem. But if the patient loses nerve cells, ricin may be too dangerous to use."

Some doctors are sure that ricin is too risky. "We've put in eight years learning to use radiation safely, finding out how it will affect every tissue in the body," says Dr. Order. "Why do it all again for a new toxin?"

But Order has high confidence in other antibody therapies, and he flashes impatience at doubters. "The usual idea is that you cannot use an antibody against cancer that also acts against proteins found in normal cells. Yet ferritin, the antigen we attack, is found in many healthy parts of the body. People have driven me crazy over the fear that our antibody to it would kill normal tissue. For a long time the Food and Drug Administration would not approve our experiments because they thought I was dangerous. But we've given people large doses of antiferritin and never hurt anybody."

Even if fears continue to prove groundless, it is anybody's guess when patients outside these limited studies will receive antibody-based cancer treatments. "Logic has never been a virtue of the medical profession in general," Dr. Schlossman comments. "It can take years to prove to people that these results are not just luck. And you must understand that we get only the most difficult patients, the ones for whom everything else has failed. Nobody is going to start patients on these experimental therapies when there are already drugs for most of these diseases that work very well."

"Yet," he adds, "if a given antibody treatment does not pan out, it won't be because the principle is wrong. It will be because we are doing something wrong, and we can improve our current strategies. It will surprise me if antibody-based therapies are not in wide use within ten years."

Other researchers agree. Karl Hellstrom, seen by others as conservative in scientific matters, declares, "In ten or fifteen years these antibodies will revolutionize cancer treatment."

PICASSO

CONTINUED FROM PAGE 66

"Picasso said that I would be an artist! I could laugh, if it weren't so sad. For the greatest artist of our times to be wrong on a matter of art!"

Midway through his story, weariness had forced Weil to sit down. Now he grasped the arms of his chair, still staring down at the desktop. "I could have been an artist—once. No more. An artist needs to have an enormous ego in order to create, and I don't have it now. Not after the life I've had. It was all kicked out of me."

Slowly, painfully, he stood. Holding the plate up into the light, he watched it flash and sparkle. "There is a lesson in this for you. I tried to support everyone with my work—my mother, my family, my country, and then my other family. Now all the people I loved are dead, and I realize that this was wrong. I should have been like that little orange roof. Supporting from a distance."

He glanced up. "Eh? What do you think?"

But the customer was no longer there. His chair contained nothing but shadows, and save for the old man the shop was empty. Weil shook his head in chagrined puzzlement. If his maunderings had driven a customer away, he could understand. But the man had left without his plate.

Then, too, he should have *heard* the man leave. No matter how deeply sunk in his reveries he had been, he should at least have heard the bell over the door. Only the deaf or the senile fail to notice when people leave.

"I truly am growing old," he said sadly.

Mocking laughter burst out of nowhere and filled the room. Dark and sardonic, it roared and reverberated.

Weil spun about fearfully and saw nothing. Only a solid wall separating the shop from the rest of the house. The laughter must have come from beyond. He decided, and took a step backward.

And Picasso walked jauntily through the wall as if it weren't there.

"So, my sorcerer's apprentice—not so young now, eh? Not so spry around the knees and elbows. I tell you there were times I thought you would *never* get the lesson."

The old man leaned heavily against his desk. "*Maître!*" he gasped. "But you—you are dead."

The Master laughed scornfully. "Death. Bah! Death is just another God-damned limitation. How many times do I have to tell you? The artist's job is to go beyond these limits." His manner was so quick and alert that by his very presence he made the shop a dreary and confining place.

Weil gingerly stretched out a hand, not daring to touch. His heart was pounding wildly. "You—*look* like him. But perhaps I am going mad."

Picasso's voice was almost gentle as he took Weil's hand. "My poor little apprentice! The first lesson, though, is always the roughest. Come, we have unfinished business back in Paris."

But the old man hung back. "Can it be?" he murmured to himself. Then, "No. I am too old."

"Old!" Picasso sneered. Weil shivered as if touched by a crisp autumn breeze. "Age is just another limitation—move *around* it." He looked stern. "In time you must learn to do this yourself. I am not your Daddy, to look after you every instant of every day. But this once I am at your disposal. I can return to you your youth, your will, the years you have wasted. Only tell me what you want."

"I—" He stopped and swallowed. "I want to be an artist! I want to sculpt again! I want to form stone and clay and bronze into shapes that have never been seen before, that no one but I could create!"

"All this you shall have," Picasso promised. He seized Weil's shoulders, turned him toward the wall. "Come, it is time for your next lesson."

And as the wizard shoved him through the wall, through the cold decades and vast distances and weary regrets that were, after all, only limitations, he snarled, "But from now on let's get it right the *first* time!" DD

A Nobel Prize-winning astrophysicist who was in the front lines at Los Alamos tells why the public must welcome in the age of nuclear power

INTERVIEW

HANS BETHE

The sun has been shining for billions of years but it took a Hans Bethe to figure out just how it works. (His name is pronounced Bay-te.) His discovery, made in 1938, was the culmination of his work in the then-dawning field of nuclear physics. For nearly 20 years a number of very good physicists had been speculating on the kinds of nuclear reactions that might take place deep within the interior of the sun and other stars to provide the sunlight and starlight we receive. Bethe did more than speculate; he approached the problem systematically. Picking and choosing adroitly among the possibilities, he put together two sequences of nuclear reactions—the proton-proton cycle and the carbon cycle—then showed that, under conditions lo be expected in the interior of the sun and other stars, these sequences would indeed produce energy at the observed rates. For this, he was awarded the Nobel Prize in physics in 1967.

Born in Alsace-Lorraine in 1906, Bethe was one of the generation of brilliant physicists who flourished in Europe during the 1920s and early 1930s, when modern atomic theory was being born. Adolf Hitler's rise to power signaled the end of that period, and, in 1935, Bethe emigrated to the United States, where Cornell University in Ithaca, New York, has been his home base ever since. He was taken aback by the discovery, in 1939, of a new kind of nuclear reaction—the fission of uranium. He knew from the outset that, with war looming, this discovery could lead to the development of an atom bomb. Only in 1942, however, did he become convinced that the bomb could be ready in time to be used during the war. He then joined the Manhattan Project and soon rose to direct the Division of Theoretical Physics at Los Alamos, New Mexico. For his work on the project he received the Presidential Medal of Merit from Harry S. Truman in 1946.

PHOTOGRAPH BY DAVID MICHAEL KENNEDY

Bethe's exceptional understanding of physics, his background in government service, and his ability to address a broad range of scientific problems made him a natural leader in the world of postwar physics. He was one of the founders of the Big Bang theory of the origin of the universe. He also contributed to some of the earliest studies on power-producing nuclear reactors and, in 1949, authored the first paper on the safety of fast-breeder reactors. Along with many of the other senior leaders of the Manhattan Project, he was disturbed about the implications of his work and was thus led into the world of public policy. During the 1950s he served as a member of the President's Science Advisory Committee, which was concerned with nuclear issues at the highest government levels. He also worked on the space-missile-reentry problem, examining what happens to a missile's nose cone when it reenters the earth's atmosphere at 25 times the speed of sound. In 1958 and 1959 he was a member of the U.S. delegation at Geneva that negotiated with the Soviet Union on an end to nuclear testing. This led to a three-year moratorium on atmospheric tests. He was also influential in arguing against deployment of the Sentinel antiballistic missile (ABM) system—a plan that was eventually abandoned by President Nixon in 1972.

In recent years Bethe has not hesitated to plunge full tilt into debates over nuclear power. In a controversial article published in *Scientific American* in 1976, Bethe asserted that during the next quarter century nuclear energy will be the only available alternative to fossil fuels. The general public is not well enough informed about science and technology and our role in our society," he wrote. "This allows any number of nuts to dispense misinformation couched in noble rhetoric." Taking his lead from antinuclear activists, he went on to marshal dozens of his fellow scientists as signers of a pronuclear petition that argued that objections to nuclear power should be outweighed by the benefits it would provide.

Today Bethe continues to be a vigorous nuclear advocate who looks ahead to the success of fusion power—the earliest studies of which drew directly from his encyclopedic writings on nuclear reactions.

What does Bethe see as the future of the world's energy supplies, of nuclear power, of fusion, and of physics? To find out, science writer T. A. Heppenheimer interviewed Bethe in his office at the California Institute of Technology in Pasadena, where he was a visiting professor.

Omni Dr. Bethe, you were involved with fission literally from the beginning. You were at Cornell when Niels Bohr arrived on the S.S. *Drottningholm* in 1939 and brought the news of its discovery to scientists in America. How did you first learn about it?

Bethe I learned about it, I think, from people around me who were talking about it. I had one physicist colleague at Cornell, Georg Placzek, who was terribly interested and began working on this immediately. Then I learned more about it at a little meeting of some theoretical physicists in Washington. This was in March of 1939, and the whole subject of the fission of uranium was discussed there. Generally, our sessions were open to the press, but in this case we closed the meeting. [Enrico] Fermi and [Leo] Szilard both outlined the possibilities of a chain reaction and of a nuclear weapon. It was not at all clear that all this could be done. But these people at least saw the possibility.

Omni When you first heard these presentations, how did you respond?

Bethe I thought it was largely speculation that it would take lots of experimentation before it would become a real possibility. I was most interested in this, at the time, because of the impending war. But I thought it was unlikely that nuclear fission would lead to a weapon that could be useful in the war. And therefore I didn't want anything to do with it. Instead, I concerned myself with such matters as projectiles penetrating armor plate and with underwater pressure waves from explosions. Most important was radar. That was what I worked on in the early years of the war.

> *"I thought it unlikely that the discovery of nuclear fission would lead to a weapon that could be useful in the war. And therefore I didn't want anything to do with it."*

Omni Then you did not associate yourself with the group that included Fermi, Szilard, and Einstein?

Bethe Not Einstein.

Omni Well, Einstein signed the letter to President Roosevelt in August 1939, warning the President that the Germans might be working on an atomic bomb.

Bethe Definitely. He signed the letter, but he never, never worked on the bomb or on the Manhattan Project.

Omni So you were not associated with the early group of physicists who, in 1939, sought to bring the potentials of nuclear weaponry to the attention of the highest levels of the U.S. government.

Bethe That's correct. Nor was I associated with the group that tried to find out whether it was a real possibility.

Omni And yet shortly thereafter, beginning in 1943, you headed the Theoretical Physics group at Los Alamos.

Bethe That I did, yes. I joined the project in the summer of 1942, when it was shown to me that Fermi's chain reaction in the pile in Chicago was almost certain to operate. I had a secret briefing, which gave me this information.

Omni How did you get into that position in Los Alamos?

Bethe I was a well-known nuclear theorist. Apart from Robert Oppenheimer, who was the leader of the project, and Eugene Wigner, who was busy at Chicago, I was probably the most knowledgeable person in nuclear physics.

Omni Have you seen the TV series *Oppenheimer*? If you did, how do you feel about its portrayal of your colleagues and of yourself?

Bethe I watched it regularly. On the whole it reflects the spirit of Los Alamos very well and presents very good characterizations of my colleagues. As for Oppenheimer himself, it's very good, except I don't believe—in the second episode—Oppenheimer tried quite so hard to persuade [General Leslie] Groves to make him director of the project. Many things the film says about me are wrong. I never lost my temper in Oppie's office while complaining about Edward Teller. And there are other mistakes. Some things are more dramatized than others, for instance, in episode five, the incident of Groves and Oppenheimer taking [George] Kistiakowsky to task [over a failed simulation of the bomb detonation]. That wasn't correct. But these are not really major criticisms.

Omni What were some of the matters with which your group at Los Alamos was concerned?

Bethe First, we wanted to know the critical mass. We had available to us detailed data on cross sections of neutron reactions. And from these data we wanted to determine how much material we needed, and thereby determine how much fissionable material the large facilities, such as those at Oak Ridge or Hanford, would have to produce. Second, we wanted to figure out how much energy could come out from such a device, what it would do in less than one millionth of a second, how it would produce the energy. That was a much more difficult problem. Third, in the beginning we had a certain design—the so-called gun assembly—in which two halves of a sphere of uranium were shot together. We wanted to know how such an odd shape of material would act, and, in particular, whether it would predetonate—whether we would get a fizzle rather than a bang.

Omni Solving these problems would have required a great deal of computation. There were no electronic computers in those days. What did you do?

Bethe To begin with, we had adding machines that you turned with a crank—we had cranking machines by the dozens, and a number of people who operated these hand calculators. But we also had electromechanical computers—the old IBM ma-

chines They combined electric sensing—reading data off punch cards—with mechanical computation They were quite good They could add, subtract multiply and divide at fairly good speed A major multiplication might take them a second And there were very high-class physicists and mathematicians engaged in writing the programs One of them was [Richard] Feynman here at Caltech There were three very knowledgeable people helping him as well as others less trained They kept the machines in running order One of my friends said at a later time "These are my card-carrying Ph D s"

Omni: You received a Nobel Prize in 1967 for your work in astrophysics on the energy reactions that power the sun and the stars How well has that work held up during the intervening decades?

Bethe: Very well There are two reactions that power the stars, both of which use hydrogen You can calculate how at the center of a star the hydrogen will get used up The sun is about halfway through its hydrogen life giving it five billion years of further life which is quite satisfactory But some stars, about the size of the sun have come to the end of the hydrogen in their central region They still have lots of hydrogen outside but when they come to the end of this central hydrogen, their centers collapse causing their central temperatures to climb about five times higher than they were before And paradoxically, the star as a whole expands That makes it a giant Now I consider one of the most striking proofs of the general idea of nuclear energy production in the stars is the existence of red giants The details of how a red giant develops—increasing its luminosity getting cooler and bigger then shrinking again as the center gets hot enough for helium to react then expanding again—work out extremely beautifully and in accordance with the general ideas of nuclear reactions

Omni: Tell me about these fundamental nuclear reactions

Bethe: The proton-proton cycle and the carbon cycle both work by fusing protons—hydrogen nuclei—into helium nuclei In the proton-proton cycle you have what amounts to direct accumulation of the nuclei In the carbon cycle protons accumulate onto a carbon nucleus until finally a helium nucleus splits off leaving the original carbon again And both these reactions, both these cycles produce enormous amounts of energy

Omni: You played a major role in developing the understanding of both these cycles

Bethe: Yes that's true The proton-proton reaction was really discovered in 1938 in Germany by Carl von Weizsacker who has not received enough credit for this discovery and who has received too much credit for discovering the carbon cycle which is interesting Nobody mentions him with regard to the proton-proton reaction, and that really was his discovery and his alone

CONTINUED ON PAGE 121

Luscomb saw a mammoth cigar-shaped object as long as four 747s glide easily across the sky

ANTI MATTER

UFO UPDATE

The sun set over the mou tal s of Re serve, New Mexico and soon the stars were shining bright Then suddenly the early even ng alm was shattered by the sound f r jet swooping through the mountain passes The pilots were clearly searching for something And Dan L uscomb thought he knew what it was

Just an hour earlier on that evening of December 8, 1981 Luscomb had allegedly witnessed a cigar-shaped object glide effortlessly across the twilight sky It was as big as four 747s linked together recalls Luscomb who owns the Whispering Pines Resort seven miles south of Reserve "A jet was in pursuit straining to keep up with the thing Luscomb adds But every time the plane got close the object slipped away

Luscomb s account was soon picked up by a reporter from the nearby *El Paso Times* The tiny article might have gone virtually unnoticed but as it turned out J Allen Hynek director of Chicago's Center for UFO Studies chose just that day to visit his private New Mexico observatory He was dr ving through the city of El Paso when he picked up a copy of the *Times* and read the story

A few months later in April 1982 Hynek decided to investigate by visiting Reserve itself In the days that followed, he interviewed dozens of local people Nine wit nesses in all he found swore they d seen the cigar-shaped object just about the same time as Luscomb did

Lance Swapp for instance, declared he saw a bright light while driving home from his job at Jake s Grocery

[illegible] When Swapp re[illegible] pro her was [illegible] me to look up ky There w[illegible] large object ove[illegible] heads with a jet o[illegible] is trail And housewife Alma Hobbs who was on her way to Luscomb s resort said she observed a red ball rising from the ground Within sec onds apparently turned sideways o resemble a tube

The Federal Avia tion Administration Hynek soon discov ered, claimed that t had picked up nothing unusual on its radar screen that night and the Air Force said t had dispatched no jets to the area Nevertheless Hynek was con[illegible]ced that the people of Reserve and Luna were on the level and he set out to see whether he could determine what the unidentified object might be

Back at his center in Chicago however he found himself rejecting one theory after another Because of the object s shape for example some people suggested was a missile But missiles make a deafening noise and this object was silent Others said the mysterious object might be a military test vehicle But Hynek contends that no known technology can make a ninety-degree turn seconds as this object allegedly did The feat he edds defies Newton s Second Law of Motion "

Whatever the object is Hynek concludes t doesn t seem like something constructed by man As for the Air Force officials' denials he believes "It would embarrass them to admit there was something in the skies they did not understand —*BETHANY CAMPBELL*

BIG FOOT FRAUD

For centuries Indians told of an apelike giant who roamed the crests near Mount St Helens in Washington The myth seemed to blend with reality when people started finding giant footprints in the late 1920s But now an aging mountain man says the modern proof for the creature called Bigfoot is merely an elaborate fraud

I whittled those feet fifty four years ago says eighty five-year old Rant Mullens (above) a retired logger from Toledo Washington It was just a practical joke

Mullens says it all started in the late 1920s when he thought he'd play a joke on some huckleberry pickers who occasionally visited the mountains He whittled a couple of pieces of alder wood into 14-inch-long human feet with primitive heels and thick blunt toes A friend grabbed the feet by the poles they were attached to and walked around where the pickers would be Mullens says When the pickers saw those huge footprints they went running all out • breath

The Bigfoot tales might have died soon afterwards, says Mullens except that the joke soon got out of hand Mullens stored the whittled feet in a logging shed but a friend swiped them and carried on leaving footprints throughout the country Mullens regained the wooden feet in the late 1940s but later he was enticed to sell them and six newly whittled pairs to a man from California And so 'proof' of Bigfoot he confesses spread throughout the Northwest

Those who believe in Bigfoot say there is more evidence than Mullens's primitive footprints including eyewitness sightings and candid films But to Mullens the whole thing is 'poppycock' spun off from his original fraud Anyone who believes in Bigfoot, he snaps has to be pretty narrow between the ears

—Douglas Starr

PET TELEPATHY

Is your cat crying? Your Doberman in decline? Phyllis Moline (below) may be able to help She a Tennessee psychic who specializes in reading the minds of troubled animals And according to one Nashville shelter operator she has already brought speedy comfort to dozens of pets including some 50 dogs

We had a great Dane recalls Judy Myers executive director of Action for Animals He was wasting away just lying there looking at you with those big sad eyes Phyllis new immediately that he was in [illegible]

ing because his blanket had been taken away When we got him a blanket there was a total transformation And I have a German shepherd One of his previous owners beat him terribly damaging his pancreas Phyllis picked it up

How does Moline work her miracles? It's a matter of using the right and left brain balanced together along with the movement of the perennial gland, she says 'A social worker gave me the scientific explanation for it but I can never remember

Phyllis says she's been psychic all her life but really flowered at age twelve when her father was transferred to India to help build a factory I kept meeting gurus on the street and they already knew my name It was really strange With blessings from her mother a yogi young Moline finally went to study in a Buddhist retreat where she lived until her family returned to the United States five or six years later

It doesn't take years in an ashram to learn animal telepathy though "ve been giving free workshops teaching people to communicate with animals,' she reports They learn how to find out their pets problems and how to make them obey when they give a command even if they do it only in their minds "

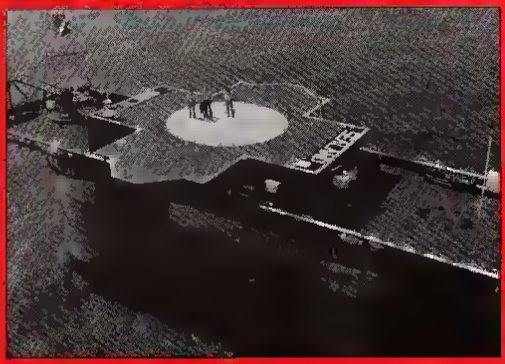
Owen Davies

'Man's most valuable trait is a judicious sense of what not to believe

—Euripides

SEALAND

A huge steel platform rising out of the turbulent North Sea may soon become one of the most lucrative nations in Europe This tiny kingdom which goes by the name of Sealand is located a mere



60 miles from London but it has its own currency and stamps, an army and even a heliport

Sealand (above) may sound like a fairy tale, but it has a real history It began as a 140' × 40' fortress built by the British during World War I After the war, the pletform was abandoned and British millionaire Roy Bates started thinking he'd like to own it himself

Plotting with his wife, Joan and his son Michael Bates invaded the fortress from a small boat 15 years ego When a British ship finally arrived for a showdown Michael shot at its bow The vessel sped away and the real battle over Sealend was waged in the courtroom where Bates came out triumphant Englend had relinquished its legal right to the slab the court decided and it belonged to anyone who settled there The 'principality of Sealand came into being officially in 1967—with the Bateses as its monarchs

According to Joan Britain was loath to cooperate with Sealand in the early days But now she says "The English help us beceuse they know we'll be a commercial asset Indeed if the Bateses vision materializes calling Sealand a 'commercial asset would be putting it mildly Michael says that engineers end a business group are now drawing up the final blueprints to turn Sealand into "the marketplace of Europe a bureaucracy free port similar to Hong Kong'

The Bateses plan to buy tons of cement and landfill to extend the island's boundaries dozens of miles And they are seeking additional capital to build gambling casinos an amusement park modeled after Disney World an exclusive residential area, and Europe's largest gold and silver market —Kathrine Jason

It is in our idleness in our dreams that the submerged truth sometimes comes to the top
—Virginia Woolf

LIVING NEANDERTHALS

Whet happened to Neanderthal man? According to one view he was killed off in battles with modern man Another theory has it that the Neanderthals—a relatively sophisticated moral and intelligent subspecies—mated with their *Homo sapiens* competitors producing offspring that evolved into the European people of today

Now there is yet another hypothesis A respected archaeologist at Britain's University of Leicester proposes that small Neanderthal bands may still be alive and well in Outer Mongolia After reviewing many Soviet reports of the Neanderthal-like wild man known as *Almas* Dr Myra Shackley concludes that the idea that modern man can be the only surviving hominid species is outmoded biological arrogance It seems impossible she says "to deny the existence of the *Almas*

According to reports of the *Almas* have come from responsible citizens including scientists in the rugged high mountain areas of southern Russia and central Asia Moreover during fieldwork in Outer Mongolia one of the most desolate places on Earth Shackley herself found Neanderthal looking stone tools She crisscrossed the fringes of the Gob Desert and the Allai Mountains asking about the origins of the tools invariably she relates herders stated that they were made by people who used to live in the area'

These people the Mongolians told her currently inhabit caves high the mountains where they hunt for food The herders were surprised that anybody would be so interested in the cave dwellers or *Almas* Shackley says To the Mongols they were common knowledge

Most scientists will doubtless react negatively to Shackley's views recently published in the prestigious archaeology journal *Antiquity* Nevertheless Shackley proposes more fieldwork in Mongolia to find further archaeological remains—or perhaps the Neanderthals themselves

J Richard Greenwell

Round about what is, lies a whole mysterious world of might be a psychological romance of possibilities and things that do not happen'
—Henry Wadsworth Longfellow

ANTI MATTER

MESSAGES FOR THE DEAD

Men and women have whispered messages into the ears of the dying for thousands of years. If the terminally ill can somehow reach the afterlife, the age-old theory goes, they might be able to deliver messages to friends and relatives long since dead.

Now a Granada Hills, California, firm is capitalizing on this mystical communication. For a fee of $40, Heaven's Union says, it can deliver a message of 50 words to the deceased by way of a terminally ill patient or "messenger." According to company founder and president Gabe Gabor (pictured at right), the firm has already distributed 2,500 messages to 15 ailing messengers. Six of those messengers," he adds, "have recently departed."

Heaven's Union hires paradise-bound messengers through psychologists at hospitals. Gabor explains. And for each communication carried, the messenger's heirs are paid $10. After the money has changed hands, the messengers simply read each message. They need not commit it to memory, Gabor says, because, when we leave our body behind, the spirit is able to recall all things from life.

Gabor's brainstorm for Heaven's Union came in the aftermath of his mother's death, when he instinctively asked a terminally ill friend to carry a message to her. "I know my mother received

the message," he says, "because I have an inner feeling of peace."

As for criticism of Heaven's Union, Gabor says that "the greatest opposition comes from the clergy. They had a monopoly on heaven for years." —Eric Mishara

"Doubt is the vestibule which all must pass before they can enter into the temple of truth."
—Charles Caleb Colton

VAMPIRE HALL OF FAME

Would you like to see the 1951 version of *The Thing*, a movie about a space carrot that sucks the blood of arctic sled dogs? Have you been pestering book stores for a copy of *The Hunger*, the tale of a gorgeous woman vampire who haunts New York City, seducing her meals?

If the answer to either of these questions is yes, you're in luck. A wealth of vampire-related arcana, ranging from Bram Stoker's fiction classic *Dracula* to the award-winning TV film *The Night Stalker*, will soon be available at the Vampire Hall of Fame in Queens, New York. Under construction by Stephen Kaplan, of the Vampire Research Center, the new hall will keep the media and public informed about the new science of vampirology. "After a decade spent interviewing individuals who must drink human blood in order to sustain themselves," Kaplan says, "I feel it's time to share my findings with others."

Toward that end, Kaplan has already stocked the Hall of Fame with manuscript copies of his own book, *Vampires Are*, to be published on Friday, May 13, 1983. A guide for those interested in becoming vampirologists, the book advises its readers against visiting a vampire alone.

For safety's sake, the interviewers should outnumber the vampire subject substantially, Kaplan asserts, "but for the best defense, I talk to them over the phone."

In addition to books and movies, the Hall of Fame will also contain photographs of ground-breaking researchers in the field. The only individuals thus far given this honor are Kaplan himself and his wife, Roxanne Saiche Kaplan, an important member of his staff. —Henry Packer

In English the word supernatural must do service as both adjective and noun; there is nature, but no supernature. Perhaps this is a real and not merely a linguistic truth."
—Douglas Hill and Pat Williams

OOPARTS

CONTINUED FROM PAGE 58

accepted article of faith. Among his detractors are anthropologist Stuart D. Scott and geologist Charles J. Cazeau, authors of *Exploring the Unknown*. "Anyone can come up with a conjecture and be selective with the evidence, which is what I think Fell has done," Scott said recently. "We question Fell for concluding too much from too little."

Brian M. Fagan, Distinguished Professor of Anthropology at the University of California at Santa Barbara, is even more vociferous in his opposition to Fell. "There is *not one shred* [emphasis his] of scientifically collected evidence to support his contention that Celts and others visited the Americas as far back as 800 B.C."

And what of the Davenport Calendar Stele? Is it a fake, as early investigators at Harvard and the Smithsonian claimed, or is it an example of an authentic find that has been called spurious simply because it could not be understood at the time of its discovery?

Fell argues that the Iowa tablet cannot be a forgery, because neither Libyan nor Iberian Punic had been deciphered in 1874. His supporters include the New England Antiquities Research Association. Although John S. Kopper, chairman of the department of sociology and anthropology at C. W. Post College in Brookville, New York, does not count himself as a Barry Fell fan, he concedes that "his views may well prove true: the voyage from Europe would have been trying but not impossible. Right now, however, we don't have the good, substantial evidence we need."

The rise of civilization is usually seen as a step-by-step process marked by a gradual increase in understanding. The very existence of ooparts, however, suggests that enlightenment can occur in sudden fits and starts. Early man's technological feats may simply attest to his spotty comprehension of the world, wherein gaping holes in knowledge were offset by startling expertise in certain areas. One has only to look at the pre-Incan cultures to appreciate just how sharply the ancients were divided between ignorance and superstition on the one hand, and brilliant insights and discoveries on the other.

During the advanced Bronze Age and Iron Age the people of the Andes had no wheel, no money, and no written language, yet they knew how to channel water into desert valleys through intricate irrigation systems and how to span deep mountain gorges with suspension bridges. They had bred some 30 food crops by the time the Spanish arrived; they had mummified their dead and woven textiles in a way that has preserved their vivid colors to this day. They used quipus, or knotted strings, to keep official records and, in the opinion of many experts, as an astronomical calendar as well. Now, because of the new discipline of paleopathology—the study of ancient disease—yet another wonder of Andean civilization has come to light.

In 1970 Marvin J. Allison, a paleopathologist at the Medical College of Virginia, traveled to Ica, Peru, under the auspices of the National Geographic Society. Working with Alejandro Pezzia, curator of the Regional Museum of Ica, he examined 288 mummies interred by the Huari, Nazca, and Ica cultures during the period 6000 B.C.–A.D. 100. They discovered that ancient Peruvian doctors were just as eager to perform brain surgery as were Western doctors of the time—with one notable difference. The pre-Incan surgeons succeeded about 74 percent of the time, whereas their European counterparts had a 100 percent failure rate.

Trephination, or removal of parts of the skull, was usually performed to extract bone splinters from head lesions or to correct bone disease and skull fractures. The success of the procedure, according to Allison, can easily be determined from the way bone healed around the head wound. Remarkably, the instruments used to carry out these complex and dangerous brain operations were simple blades made of volcanic glass. Since the early inhabitants of the Andes had no writing, it is still not understood how this highly technical knowledge was disseminated to other doctors. What is known, Allison reports, is that "more trephinations were done in ancient Peru than in all the rest of the ancient world combined."

Whatever the final answers, it cannot be denied that these pre-Columbian cultures possessed skills that continue to astound and confound archaeologists to this day. Indeed, few ancient legacies have inspired more awe and wonderment than the intricate maze of open-air chalk drawings that the Nazca tribe (100 B.C.–A.D. 800) bequeathed to posterity. These "landing strips of the gods," as they have been dubbed in the popular press, crisscross the Nazca plain, 16,000 feet up in the Andes. Most baffling of all: they can be distinguished only from the air.

At ground level, the Nazca pictographs present a flat appearance. It is not apparent that some of the lines continue for distances up to five miles, ending at the base of a mountain and continuing in perfect alignment on the other side. Not until the 1930s, when commercial airlines began operating in the Andes, were these "earthworks" correctly recognized for what they are: drawings of birds, spiders, monkeys, snakes, fish, and other animals, plus long, razor-straight lines that intersect to form triangles, trapezoids, and rectangles. Other lines spiral outward from mounds of rocks. Originally made by removing a top layer of pebbles and exposing the yellow chalk underneath, the pictographs have been tentatively dated to A.D. 200–300.

The animal drawings, especially, present intriguing puzzles. Most of them of a geographic nature. For instance, one

drawing is of a spider 150 feet long, drawn with a single continuous line half a mile in length. One of its legs is deliberately extended, and there is a small cleared area at its tip. The spider has been identified as *Ricinuleus*, an arachnid species indigenous to the Amazon Jungle, some 1,000 miles from Nazca. Its unique mode of reproduction, for which it uses its extended leg, can be observed only with the aid of a microscope.

Another drawing shows a thin-limbed monkey, not unlike the spider monkey, another species unique to the Amazon. And on a piece of Nazca pottery is the detailed outline of a white-breasted, black-coated penguin, an animal native to Antarctica some 4,500 miles away.

"It does not surprise me that the Nazcans portrayed animals and insects from distant places," said Anthony Aveni, an anthropologist at Cornell University, in Ithaca, New York, who is currently conducting a study of Nazca for the National Geographic Foundation. "The ancients got around quite a bit. They're only fifty miles from the sea. I think we tend to underestimate what early people were capable of."

For the past two seasons Aveni, Tom Zuidema, an anthropologist at the University of Illinois, and Gary Urton, an ethnologist who has worked in the Andes for 30 years, have performed a vast mapping project of the Nazca plain. Their principal interest is in the ray lines that emanate from the stone mounds. They have mapped 17 such centers so far and plan to continue their studies through 1983.

"We believe the problem has not been looked at holistically," Aveni asserts. "Astronomy may be one explanation for Nazca, as some experts believe, but our computer analysis is not yet complete. We just don't know."

The Nazca drawings have survived over the centuries because of the dry, windless desert climate. Time has preserved them, now it is up to man to interpret them.

Oparts, by their very nature, are bound to arouse controversy. That they exist is beyond doubt; how to *explain* them is the bone of contention between the academics. Ranged on one side are those who, like Charles H. Hapgood, believe that "the evidence for an ancient worldwide civilization—or a civilization that for a considerable time must have dominated much of the world in a very remote period—is rather plentiful. We have manifold leads that further research can hardly fail to develop."

On the other hand, there are the more orthodox scientists, such as Charles J. Cazeau and Stuart D. Scott, who "lament the homage accorded to those mysteries so amenable to solution by logic and clear, critical thinking. Yet the day when all genuine mystery is dissipated ... would be equally lamentable, for it has always been the attraction of mysteries and the overwhelming urge to solve them that have carried mankind from Stone Age campfires to exploration of the planets." ∞

TOMORROW

CONTINUED FROM PAGE 72

70mm 3-D film created by director Murray Lerner, who moved to the EPCOT project following his Academy Award-winning *From Mao to Mozart* documentary.

Film will play an important role in all of the park's presentations, partly because motion pictures were Disney's major stock-in-trade for more than four decades. Using films also gives Disney designers greater flexibility in updating the exhibits. Certain facts, predictions, and concepts in each of the subject areas will be changing in the decades to come, and, while something like a robot show may require extensive rebuilding and reprogramming, films can be changed more easily.

EPCOT would have been impossible without the surge in computer sophistication in the last decade, which especially allowed lifelike realism to be added to EPCOT's Audio-Animatronics figures, the Disney robots. In another building next to WED headquarters is a Disney company called MAPO (named for the Disney hit film *Mary Poppins*). MAPO is a true android factory.

A visitor to MAPO's shops would see dozens of skeletal figures bent at the waist in an "at rest" position, their innards of tubes, hinges, motors, and plungers visible through clear acrylic "skins." For making identification easy (and creating a distinctly eerie effect), each robot's naked head is left covered with its own full-head mask, zippered up the back of the skull for easy removal. The masks, all bald because the wigs are attached later, mimic Ben Franklin, Mark Twain, and several other EPCOT players.

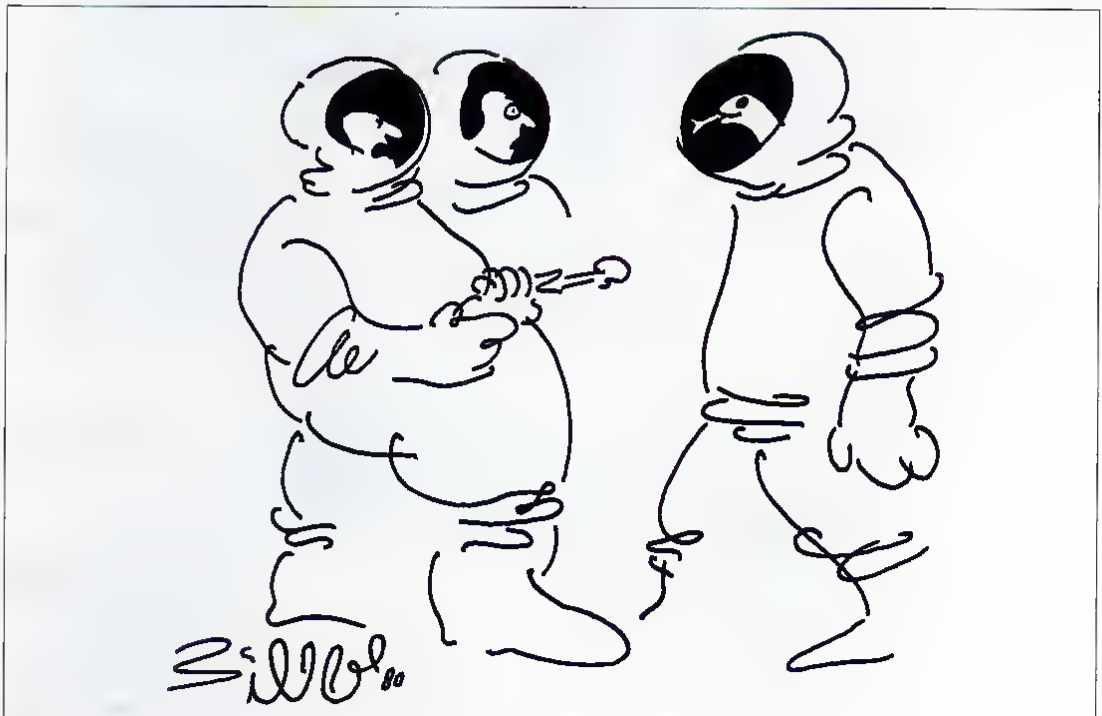
The success or failure of each Audio-Animatronics character depends on the realism of the robot's face. That comes from MAPO's Head Shop, where Marcel Aubard, a French machinist who came to MAPO from the aerospace industry, uses aesthetics as much as mechanical ingenuity to design and construct the heads. Aubard is meticulous in giving life to each of his designs, even to installing tiny relays into some of the robots' lower lips so they appear uncannily realistic while making an *f* sound, for example.

All of this hardware and these films will collectively offer the Disney vision of the future, but, Sklar cautions, "I think the big danger of this project would be to suggest this is everything you want to know about the future. It isn't. Let's use the word *turn-on*. We're saying, 'You have a stake in this future. Find out more about it.'"

The turn-ons, though, come with the imprimatur of the world's largest corporations. The energy story is told by Exxon. Kraft is behind The Land. GM sponsors Transportation. AT&T is the principal backer of CommuniCore. Even the U.S. pavilion is sponsored, not by the government, but by American Express and Coca-Cola. Why should Exxon guide us through our energy future or General Motors tell us how we'll get there?

Sklar responds, "Doesn't that put more responsibility on us at Disney? We have to make sure that it doesn't turn out to be propaganda. If it's not credible, people are going to see through it right away. In the same way, we feel *optimism* isn't a bad word. We've intentionally set out to surround ourselves with people who are external from Disney and external from the companies. We're in the communications business and the entertainment business. We don't want to be embarrassed by what we present."

But why does the Disney Corporation think the public will be interested in the future? Hench believes it is because people are interested in their own survival, and he feels EPCOT will give them clues about how mankind *can* survive. A more pragmatic answer may be that the Disney Corporation sees that interest in science and technology has become the trend of the decade. Space operas have been the most consistent money-makers at box offices. Video games are more than merely an American obsession. Space travel, technological toys, the future itself, now seem



"What have you done with Doctor Asimov?"

to have more allure for youngsters than Mickey Mouse himself

If EPCOT has any kind of flaw at all, it might be its excessively singular view. By design, EPCOT tells the world that the future is American and that the past, as presented in the World Showcase pavilions, belongs to Europe, Latin America, and the Orient. Japanese technical innovation doesn't show up in Japan's pavilion. Instead, the Japanese pavilion will concentrate on that nation's traditional culture and ancient feudalism. Japanese goods sold in the pavilion will be handmade.

"What do you want us to sell?" asks a Disney staffer. "Sonys?"

Yes. Exactly. Is Japanese electronic development, or the French and British supersonic transport, or the excellence of German mechanical engineering any less important to the future than American achievement? Of course EPCOT will be an American achievement. It represents the willingness of the Disney company and its corporate partners to invest in proffering a vision.

Ultimately, like Disneyland itself, EPCOT will symbolize the importance of dreaming and the necessity of having ideals. Ray Bradbury, who was a personal friend of Walt's and who is responsible for the initial concepts in EPCOT's Spaceship Earth shows, is an enthusiastic booster of the Disney dream.

"Everyone in the world will come to these gates," he says. "Why? Because they want to look at the world of the future. They want to see how to make better human beings. That's what the whole thing is about."

Is Bradbury bothered by EPCOT's optimism? After all, no cynics are accommodated in Disney's vision of the future.

"The cynics are already here," Bradbury bristles, "and they're terrifying one another. What Disney is doing is showing the world that there are alternative ways to do things that can make us all happy. If we can borrow some of the concepts of Disneyland and Disney World and EPCOT, then indeed the world can be a better place."

Questions though will continue long after EPCOT's unveiling. Disney's heirs can only wonder whether they have met their challenge. EPCOT will not be a place where people with one foot in the present and the other in the future will actually live and work. Nor will it really be so much a prediction of things to come as an attempt to inspire a feeling of optimism.

With all of its creative new applications of technology, EPCOT is really an advertisement for the achievements of the present more than for the possibilities of the future. In the relatively few instances where the long-term future *is* predicted, it is a slick, rosy one, full of invention and leisure without any indication of how chronic social and economic problems had been done away with. Despite these shortcomings, however, the EPCOT vision is so clean and error-free that even steel-hard realists may not be able to resist its allure. ∞

EYES I DARE

CONTINUED FROM PAGE 87

stone Bremen half-perceived the flutter of underlying thoughts much as a pedestrian senses the movement of trains in a subway under the pavement He concentrated on building the strength of the probe until he felt his shirt beginning to soak with sweat His vision and hearing were beginning to dim in the singleminded exertion of his effort No matter Once initial contact was made, he would relax and slowly open the channels of sight and sound

He felt the shield give a bit still elastic but sinking slightly under his unrelenting pressure He concentrated until the veins stood out in his temples Unknown to himself he was grimacing neck muscles knotting with the strain The shield bent Bremen's probe was a solid ram battering a tight gelatinous doorway It bent further He concentrated with enough force to move objects to pulverize bricks, to halt birds in their flight

The shield continued to bend Bremen leaned forward as into a strong wind There was only the concentrated force of his will Suddenly there was a ripping, a rush of warmth a falling forward Bremen lost his balance flailed his arms opened his mouth to yell

His mouth was gone

He was falling Tumbling He had a distant confused glimpse of his own body writhing in the grip of an epileptic seizure Then he was falling again Falling into silence Falling into nothing

Nothing

Bremen was inside Beyond Was diving through layers of slow thermals Colorless pinwheels tumbled in three dimensions Spheres of black collapsed outward Blinded him There were waterfalls of touch rivulets of scent a thin line of balance blowing in a silent wind

Supported by a thousand hands—touching exploring fingers in the mouth palms along the chest sliding along the belly cupping the penis moving on

He was buried He was underwater Rising in the blackness But he could not breathe His arms began to move Palms flailed against the viscous current Up He was buried in sand He flailed and kicked He moved upwards, pulled on by a vacuum that gripped his head in a vise The substance shifted Compacted, pressed in by a thousand unseen hands he was propelled through the constricting aperture His head broke the surface He opened his mouth to scream and the air rushed into his chest like water filling a drowning man The scream went on and on

ME!

Bremen awoke on a broad plain There was no sky Pale peach-colored light diffused everything The ground was hard and scaled into separate orange segments, which receded to infinity There was no horizon The land was cracked and serrated like a floodplain during a drought Above him were levels of peachlit crystal Bremen felt that it was like being in the basement of a clear plastic skyscraper An empty one He lay on his back and looked up through endless stories of crystallized emptiness

He sat up His skin felt as if it had been toweled with sandpaper He was naked He rubbed his hand across his stomach touched his pubic hair found the scar on his knee from the motorcycle accident when he was seventeen A wave of dizziness rolled through him when he stood upright

He walked His bare feet found the smooth plates warm He had no direction and no destination Once he had walked a mile on the Bonneville Salt Flats just before sunset It was like that Bremen walked *Step on a crack break your mother's back*

When he finally stopped it was in a place no different from any other His head hurt He lay back and imagined himself as a bottom-dwelling sea creature looking up through layers of shifting currents The peach-colored light bathed him in warmth His body was radiant He shut his eyes against the light and slept

He sat up suddenly with nostrils flaring ears actually twitching with the strain of trying to pinpoint a half-heard sound Darkness was total

Something was moving in the night

Bremen crouched in the blackness and tried to filter out the sound of his own ragged breathing His glandular system reverted to programming a million years old His fists clenched his eyes rolled uselessly in their sockets and his heart raced

Something was moving in the night

He felt it nearby He felt the power of it It was huge and it had no trouble finding its way in the darkness The thing was near him above him Bremen felt the force of its blind gaze He kneeled on the cold ground and hugged himself into a ball

Something touched him

Bremen fought down the impulse to scream He was caught in a giant's hand—something rough and huge and not a hand at all It lifted him Bremen felt the power of it through the pressure the pain in his ribs The thing could crush him easily Again he felt the sense of being viewed inspected weighed on some unseen balance He had the naked helpless but somehow reassuring feeling one has while lying on the X-ray table, knowing that invisible beams are passing through you searching for any malignancy probing

Something set him down

Bremen heard no sound but sensed great footsteps receding A weight lifted from him He sobbed Eventually he uncurled and stood up He called into the blackness but the sound of his voice was tiny and lost and he was not even sure whether he had heard it at all

The sun rose Bremen's eyes fluttered open stared into the distant brilliance and then closed again before the fact regis-

tered fully in his mind *The sun rose*

He was sitting on grass A prairie of soft knee-high grass went off to the horizon in all directions Bremen pulled a strand stripped it and sucked on the sweet marrow It reminded him of childhood afternoons He began walking

The breeze was warm It stirred the grass and set up a soft sighing, which helped to ease the headache that still throbbed behind his eyes The walking pleased him He contented himself with the feel of grass bending under his bare feet and the play of sunlight and wind on his body

By early afternoon he realized that he was walking toward a smudge on the horizon By late afternoon the smudge had resolved itself into a line of trees Shortly before sunset he entered the edge of the forest The trees were the stately elms and oaks of his Pennsylvania boyhood Bremen s long shadow moved ahead of him as he moved deeper into the forest

For the first time he felt fatigue and thirst begin to work on him His tongue was heavy, swollen with dryness He moved leadenly through the lengthening shadows, occasionally checking the visible patches of sky for any sign of clouds It was while he was looking up that he almost stumbled into the pond Inside a protective ring of weeds and reeds lay the circle of water A heavily laden cherry tree sent roots down the bank Bremen took the last few steps forward expecting the water to disappear as he threw himself into it

It was waist-deep and cold as ice

It was just after sunrise that she came He spotted the movement immediately on awakening Not believing he stood still just another shadow in the shade of the trees She moved hesitantly with the tentative step of the meek or the barefoot The tasseled sawgrass brushed at her thighs Bremen watched with a clarity amplified by the rich horizontal sweeps of morning light Her body seemed to glow Her breasts the left ever so slightly fuller than the right bobbed gently with each high step Her black hair was cut short

She paused in the light Moved forward again Bremen s eyes dropped to her strong thighs and he watched as her legs parted and closed with the heart-stopping intimacy of the unobserved She was much closer now and Bremen could make out the delicate shadows along her fine ribcage the pale, pink circles of areolae and the spreading bruise along the inside of one arm

Bremen stepped out into the light She stopped, arms rising across her upper body in a second's instinctive movement, then moved toward him quickly She opened her arms to him He was filled with the clean scent of her hair Skin slid across skin Their hands moved across muscle skin the familiar terrain of vertebrae Both were sobbing speaking incoherently Bremen dropped to one knee and buried his face between her breasts She bent slightly and cradled his head with her fingers Not for a second did they relax the pressure binding them together

'Why did you leave me? he muttered against her skin "Why did you go away?'

Gail said nothing Her tears fell into his hair and her hands tightened against his back Wordlessly she kneeled with him in the high grass

Together they passed out of the forest just as the morning mists were burning away In the early light the grass-covered hills gave the impression of being part of a tanned velvety human torso which they could reach out and touch

They spoke softly occasionally intertwining fingers Each had discovered that to attempt telepathic contact meant [illegible] ing the blinding headaches that had plagued both of them at first So they talked And they touched And twice before the day was over they made love in the high soft grass with only the golden eye of the sun looking down on them

Late in the afternoon they crossed a rise and looked past a small orchard at a vertical glare of white

'It s the farm' cried Gail with wonder in her voice "How can that be?'

Bremen felt no surprise. His equilibrium remained as they approached the tall old building. The saggy barn they had used as a garage was also there. The driveway still needed new gravel, but now it went nowhere, for there was no highway at the end of it. A hundred yards of rusted wire fence that used to border the road now terminated in the high grass.

Gail stepped up on the front porch and peered in the window. Bremen felt like a trespasser or a weekend house browser who had found a home that might or might not still be lived in. Habit brought them around to the back door. Gail gingerly opened the outer screen door and jumped a bit as the hinge squeaked.

"Sorry," Bremen said. "I know I promised to oil that."

It was cool inside and dark. The rooms were as they had left them. Bremen poked his head into his study long enough to see his papers still lying on the oak desk and a long-forgotten transform still chalked on the blackboard. Upstairs afternoon sunlight was falling from the skylight he had wrestled to install that distant September. Gail went from room to room, making small noises of appreciation, more often just touching things gently. The bedroom was as orderly as ever, with the blue blanket pulled tight and tucked under the mattress and her grandmother's patchwork quilt folded across the foot of the bed.

They fell asleep on the cool sheets. Occasionally a wisp of a breeze would billow the curtains. Gail mumbled in her sleep, reaching out to touch him frequently. When Bremen awoke it was almost dark, that late lingering twilight of early summer.

There was a sound downstairs.

He lay without moving for a long while. The air was thick and still, the silence tangible. Then came another sound.

Bremen left the bed without waking Gail. She was curled on her side with one hand lifted to her cheek, the pillow moist against her lips. Bremen walked barefoot down the wooden stairs. He slipped into his study and carefully opened the lower-right-hand drawer. It was there under the empty folders he had laid atop it. He removed the rags from the drawer.

The thirty-eight Smith and Wesson smelled of oil and looked as new as the day his brother-in-law had given it to him. Bremen checked the chambers. The bullets lay fat and heavy, like eggs in a nest. The roughened grip was firm in his hand, the metal cool. Bremen smiled ruefully at the absurdity of what he was doing, but kept the weapon in his grip when the kitchen screen door slammed again.

He made no sound as he stepped from the hallway to the kitchen door. It was very dim, but his eyes had adapted. From where he stood he could make out the pale white phantom of the refrigerator. Its recycling pump chunked on while he stood there. Holding the revolver down at his side, Bremen stepped onto the cool tile of the kitchen floor.

The movement startled him, and the gun rose an inch or so before he relaxed. Gernisavien, the tough-minded little calico, crossed the floor to brush against his legs, paced back to the refrigerator, looked up at him meaningfully, then crossed back to brush against him. Bremen kneeled to rub her neck absently. The pistol looked idiotic in his clenched hand. He loosened his grip.

The moon was rising by the time they had a late dinner. The steaks had come from the freezer in the basement, the ice-cold beers from the refrigerator, and there had been several bags of charcoal left in the garage. They sat out back near the old pump while the steaks sizzled on the grill. Gernisavien had been well fed earlier but crouched expectantly at the foot of one of the big, old wooden lawn chairs.

Both of them had slipped into clothes—Bremen into his favorite pair of cotton slacks and his light blue workshirt and Gail into the loose white cotton dress she often wore on trips. The sounds were the same they had heard from this backyard so many times before: crickets, night birds from the orchard, the variations of frog sounds from the distant stream, an occasional flutter of sparrows in the outbuildings.

Bremen served the steaks on paper plates. Their knives made criss-cross patterns on the white. They had just the steaks and a simple salad from the garden: fresh radishes and onions on the side.

Even with the three-quarter moon rising, the stars were incredibly clear. Bremen remembered the night they had lain out in the hammock and waited for *Skylab* to float across the sky like a windblown ember. He realized that the stars were even clearer tonight because there were no reflected lights from Philadelphia or the tollway to dim their glory.

Gail sat back before the meal was finished. *Where are we, Jerry?* The mind-touch was gentle. It did not bring on the blinding headaches.

Bremen took a sip of Budweiser. "What's wrong with just being home, kiddo?"

There's nothing wrong with being home. But where are we?

Bremen concentrated on turning a radish in his fingers. It had tasted salty, sharp and cool.

What is this place? Gail looked toward the dark line of trees at the edge of the orchard. Fireflies winked against the blackness.

Gail, what is the last thing you can remember?

"I remember dying." The words hit Bremen squarely in the solar plexus. For a moment he could not speak or frame his thoughts.

Gail went on. "We've never believed in an afterlife, Jerry." *Hypocritical fundamentalist parents. Mother's drunken sessions of weeping over the Bible.* "I mean . . . I don't . . . How can we be . . .

"You're dead, Peabody! Would you please stop coming in to work!"

No, said Bremen, putting his dish on the arm of the chair and leaning forward. "There may be an explanation."

Where to begin? The lost years. Florida. The hot streets of the city, the day school for retarded blind children. Gail's eyes widened as she looked directly at this period of his life. She sensed his mindshield, but did not press to see the things he withheld. *Robby. A moment's contact. Perhaps playing a record. Falling.*

He paused to take a long swallow of beer. Insects chorused. The house glowed pale in the moonlight.

Where are we, Jerry?

"What do you remember about awakening here, Gail?"

They had already shared images, but trying to put them into words sharpened the memories. "Darkness," she said. "Then a soft light. Rocking. *Being rocked. Holding and being held.* Walking. Finding you."

Bremen nodded. He lifted the last piece of steak and savored the burnt charcoal taste of it. *It's obvious we're with Robby.* He shared images for which there were no adequate words. Waterfalls of touch. Entire landscapes of scent. A movement of power in the dark.

With Robby, Gail's thought echoed. *?????????. In his mind. How?*"

The cat had jumped into his lap. He stroked it idly and set it down. Gernisavien immediately raised her tail and turned her back on him. "You've read a lot of stories about telepaths. Have you ever read a completely satisfying explanation of how telepathy works? Why some people have it and others don't? Why some people's thoughts are loud as bullhorns and others almost imperceptible?"

Gail paused to think. The cat allowed herself to be rubbed behind the ears. "Well, there was a really good book—no, that only came close to describing what it *felt* like. No. They usually describe it as some sort of radio or TV broadcast. *You* know that, Jerry. We've talked about it enough."

"Yeah." Bremen said. Despite himself he was already trying to describe it to Gail. His mindtouch interfered with the words. Images cascaded like printouts from an overworked terminal. Endless Schrödinger curves, their plots speaking in a language purer than speech. The collapse of probability curves in binomial progression.

"Talk," Gail said. He marveled that after all the years of sharing his thoughts she still did not always see through his eyes.

"Do you remember my last grant project?" he asked.

"The wavefront stuff," she said.

"Yeah. Do you remember what it was about?"

"Holograms. You showed me Goldmann's work at the university," she said. She seemed a soft white blur in the dim light. "I didn't understand most of it, and I got sick shortly after that."

"It was based on holographic research." Bremen interrupted quickly, but Goldmann's research group was working up an analog of human consciousness... of thought."

"What does that have to do with... with *this*?" Gail asked. Her hand made a graceful movement that encompassed the yard, the night, and the bright bowl of stars above them.

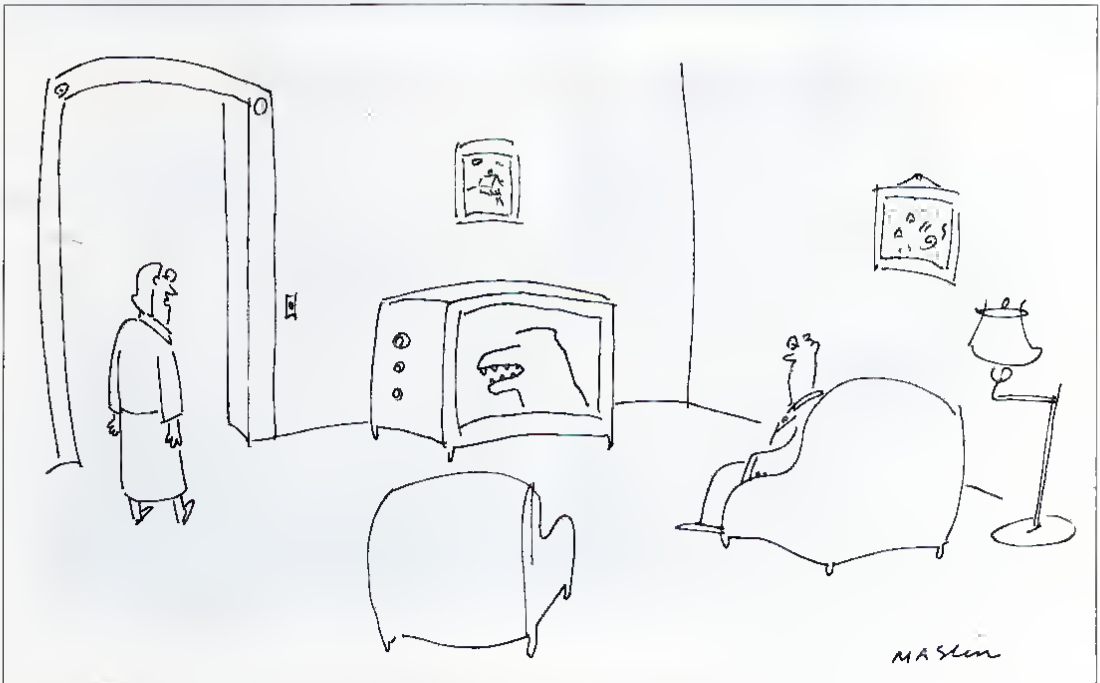
"It might help." Bremen said. "The old theories of mental activity didn't explain things like stroke effects, generalized learning, and memory function, not to mention the act of thinking itself."

"And Goldmann's theory does?"

"It's not really a theory yet." Gail. It was a new approach, using both recent work with holograms and a line of analysis developed in the Thirties by a Russian mathematician. That's where I was called in. It was pretty simple, really. Goldmann's group was doing all sorts of complicated EEG studies and scans. I'd take their data, do a Fourier analysis of them, and then plug it all into various modifications of Schrödinger's wave equation to see whether it worked as a standing wave."

"Jerry, I don't see how this helps."

"God damn it, Gail, it *did* work. Human thought *can* be described as a standing wavefront. Sort of a superhologram. Or



"Don't call me in until he's devouring something."

maybe more precisely, a hologram containing a few million smaller holograms."

Gail was leaning forward. Even in the darkness Bremen could make out the frown lines of attention that appeared whenever he spoke to her of his work. Her voice came very softly. "Where does that leave the mind, Jerry — the brain?"

It was his turn to frown slightly. "I guess the best answer is that the Greeks and the religious nuts were right to separate the two," he said. "The brain could be viewed as kind of a — well, electrochemical generator and interferometer all in one. But the mind — ah, the *mind* is something a lot more beautiful than that lump of gray matter." He was thinking in terms of equations, sine waves dancing to Schrodinger's elegant tune.

"So there *is* a soul that can survive death?" Gail asked. Her voice had taken on the slightly defensive, slightly querulous tone that always entered in when she discussed religious ideas.

"Hell, no," said Bremen. He was a little irritated at having to think in words once again. "If Goldmann was right and the personality is a complex wavefront, sort of a series of low-energy holograms interpreting reality, then the personality certainly couldn't survive brain death. The template would be destroyed as well as the holographic generator."

"So where does that leave us?" Gail's voice was almost inaudible.

Bremen leaned forward and took her hand. It was cold.

"Don't you see why I got interested in this whole line of research? I thought it might offer a way of describing our — uh — ability."

Gail moved over and sat next to him in the broad, wooden chair. His arm went around her, and he could feel the cool skin of her upper arm. Suddenly a meteorite lanced from the zenith to the south, leaving the briefest of retinal echoes.

"And?" Gail's voice was very soft.

"It's simple enough," said Bremen. "When you visualize human thought as a series of standing wavefronts creating interference patterns that can be stored and propagated in holographic analogs, it begins to make sense."

"Uh-huh."

"It *does*. It means that for some reason our minds are resonant not only to wave patterns that we initiate but to transforms that others generate."

"Yes," said Gail, excited now, gripping his hand tightly. "Remember when we shared impressions of the talent just after we met? We both decided that it would be impossible to explain mindtouch to anyone who hadn't experienced it. It would be like describing colors to a blind person." She halted and looked around her.

"Okay," said Bremen. "Robby. When I contacted him, I tapped into a closed system. The poor kid had almost no data to use in constructing a model of the real world. What little information he did have

was mostly painful. So for sixteen years he had happily gone about building his own universe. My mistake was in underestimating, hell, never even *thinking* about, the power he might have in that world. He grabbed me, Gail. And with me, you."

The wind came up a bit and moved the leaves of the orchard. The soft rustling had a sad, end-of-summer sound to it.

"All right," she said after a while, "that explains how *you* got here. How about me? Am I a figment of your imagination, Jerry?"

Bremen felt her shiver. Her skin was like ice. He took her hand and roughly rubbed some warmth back into it. "Come on, Gail, *think*. You weren't just a memory to me. For over six years we were essentially one person with two bodies. That's why when that's why I went a little crazy, tried to shut my mind down completely for a couple of years. You *were* in my mind. But my ego sense, or whatever the hell keeps us sane and separate from the babble of all those minds, kept telling me that it was only the *memory* of you. You were a figment of my imagination . . . the way we all are. Jesus, we were both dead until a blind, deaf, retarded kid, a goddamn vegetable, ripped us out of one world and offered us another one in its place."

They sat for a minute. It was Gail who broke the silence. "But how can it seem so real?"

Bremen stirred and accidentally knocked his paper plate off the arm of the chair. Gernisavien jumped to one side and stared reproachfully at them. Gail nudged the cat's fur with the toe of her sandal. Bremen squeezed his beer can until it dented in, popped back out.

"You remember Chuck Gilpen, the guy who dragged me to that party in Drexel Hill. The last I heard he was working with the Fundamental Physics Group out at the Lawrence Berkeley Labs."

"So?"

"So for the past few years they've been hunting down all those smaller and smaller particles to get a hook on what's real. And when they get a glimpse of reality on its most basic and pervasive level, you know what they get? Bremen took one last swig from the beer can. "They get a series of equations that show standing wavefronts not too different from the squiggles and jiggles Goldmann used to send me."

Gail took a deep breath, let it out. Her question was almost lost as the wind rose again and stirred the tree branches. "Where is Robby? When do we see his world?"

"I don't know." Bremen replied. He was frowning without knowing it. "He seems to be allowing us to define what should be real. Don't ask me why. Maybe he's enjoying a peek at a new universe. Maybe he can't do anything about it."

They sat still for a few more minutes. Gernisavien brushed up against them, irritated that they insisted on sitting out in the cold and dark. Bremen kept his mind-shield raised sufficiently to keep from sharing the information that his sister had written a year ago to say that the little calico had been run over and killed in New York. Or that a family of Vietnamese had bought the farmhouse and had already added new rooms. Or that he had carried the thirty-eight police special around for two years, waiting to use it on himself.

"What do we do now, Jerry?"

We go to bed. Bremen took her hand and led her into their home.

Bremen dreamed of fingernails across velvet, cold tile along one cheek, and wool blankets against sunburned skin. He watched with growing curiosity as two people made love on a golden hillside. He floated through a white room where white figures moved in a silence broken only by the heartbeat of a machine. He was swimming and could feel the tug of inexorable planetary forces in the pull of the riptide. He was just able to resist the deadly current by using all of his energy, but he could feel himself tiring, could feel the tide pulling him out to deeper water. Just as the waves closed over him he vented a final shout of despair and loss.

He cried out his own name.

He awoke with the shout still echoing in his mind. The details of the dream fractured and fled before he could grasp them. He sat up quickly in bed. Gail was gone.

He had taken two steps toward the stairway before he heard her voice calling to him from the side yard. He returned to the window.

She was dressed in a blue sundress and was waving her arms at him. By the time he was downstairs she had thrown half a dozen items into the picnic basket and was boiling water to make iced tea.

"Come on, sleepyhead. I have a surprise for you!"

"I'm not sure we need any more surprises." Bremen mumbled.

"*This* one we do," she said, and she was upstairs, humming and thrashing around in the closet.

She led them, Gernisavien following reluctantly, to a trail that led off in the same general direction as the highway that had once been in front of the house. It led up through pasture land to the east and over the rise. They carried the picnic basket between them, Bremen repeatedly asking for clues, Gail repeatedly denying him any.

They crossed the rise and looked down to where the path ended. Bremen dropped the basket into the grass. In the valley where the Pennsylvania Turnpike once had been was an ocean.

"Holy shit!" Bremen exclaimed softly.

It was not the Atlantic. At least not the New Jersey Atlantic that Bremen knew. The seacoast looked more like the area near Mendocino where he had taken Gail on their honeymoon. Far to the north and south stretched broad beaches and high cliffs. Tall breakers broke against black rock and

"Sure, the birds-and-bees routine sounds old-fashioned, but, my God, input *and* feedback?"

white sand. Far out to sea the gulls wheeled and pivoted.

"Holy shit!" Bremen repeated.

They picnicked on the beach. Gemisavien stayed behind to hunt insects in the dune grass. The air smelled of salt and sea and summer breezes. It seemed they had a thousand miles of shoreline to themselves.

Gail stood and kicked off her dress. She was wearing a one-piece suit underneath. Bremen threw his head back and laughed. "Is that why you came back? To get a suit? Afraid the lifeguards would throw you out?"

She kicked sand at him and ran to the water. Three strides in and she was swimming. Bremen could see from the way her shoulders hunched that the water was freezing.

"Come on in!" she called, laughing. "The water's fine!"

He began walking toward her.

The blast came from the sky, the earth, the sea. It knocked Bremen down and thrust Gail's head underwater. She flailed and splashed to make the shallows, crawled gasping from the receding surf.

NO!!!

Wind roared around them and threw sand a hundred feet in the air. The sky twisted, wrinkled like a tangled sheet on the line, changed from blue to lemon-yellow to gray. The sea rolled out in a giant slack tide and left dry, dead land where it receded. The earth pitched and shifted around them. Lightning flashed along the horizon.

When the buckling stopped, Bremen ran to where Gail lay on the sand, lifted her, calmed her with a few stern words.

The dunes were gone, the cliffs were gone, the sea had disappeared. Where it had been now stretched a dull expanse of salt flat. The sky continued to shift colors down through darker and darker grays. The sun seemed to be rising again in the eastern desert. No. The light was moving. Something was crossing the wasteland. Something was coming to them.

Gail started to break away, but Bremen held her tight. The light moved across the dead land. The radiance grew, shifted, sent out streamers that made both of them shield their eyes. The air smelled of ozone and the hair on their arms stood out.

Bremen found himself clutching tightly to Gail and leaning toward the apparition as toward a strong wind. Their shadows leaped out behind them. The light struck at their bodies like the shock wave of a bomb blast. Through their fingers they watched while the radiant figure approached. A double form became visible through the blaze of corona. It was a human figure astride a huge beast. If a god had truly come to Earth, this then was the form he would have chosen. The beast he rode was featureless, but besides light it gave off a sense of... warmth? Softness?

Robby was before them, high on the back of his teddy bear.

TOO STRONG CANNOT KEEP

He was not used to language but was making the effort. The thoughts struck them like electrical surges to the brain. Gail dropped to her knees, but Bremen lifted her to her feet.

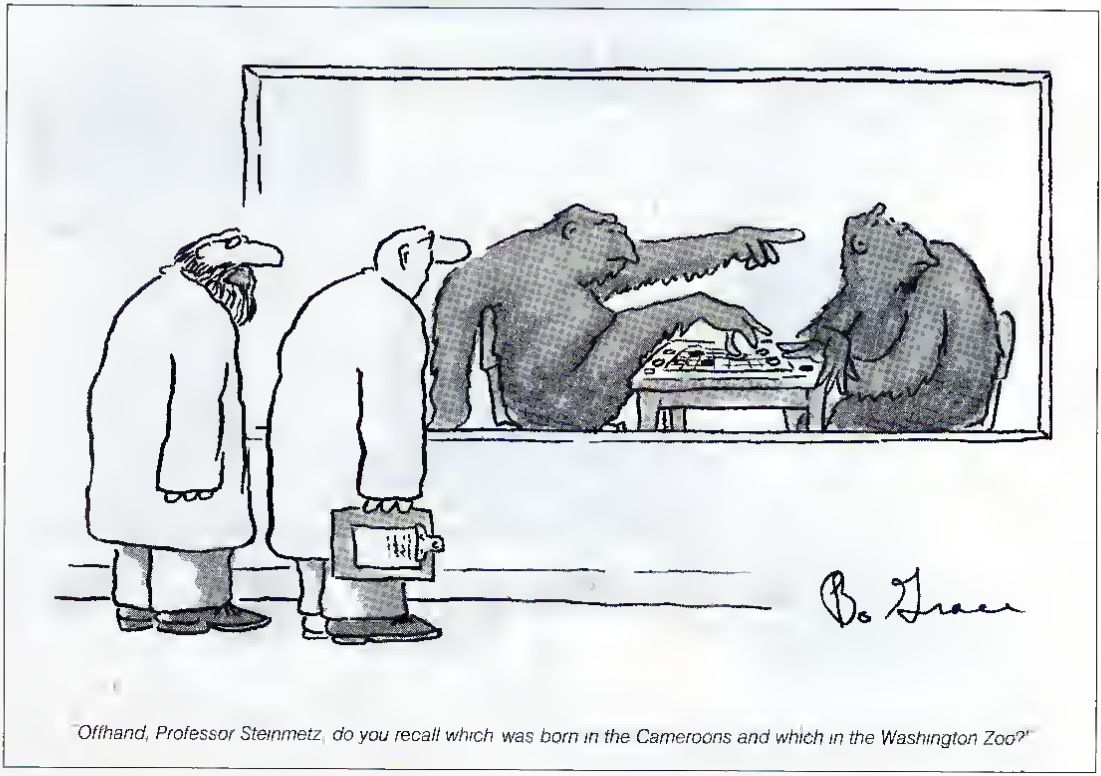
Bremen tried to reach out with his mind. It was no use. Once at Haverford he had gone with a promising student to the coliseum where they were setting up for a rock concert. He had been standing in front of a scaffolded bank of speakers when the amplifiers were tested. It was a bit like that.

They were standing on a flat, reticulated plain. There were no horizons. White banks of curling fog were approaching from all directions. The only light came from the Apollo-like figure before them. Bremen turned his head to watch the fog advance. What it touched, it erased.

"Jerry, what ..." Gail's voice was close to hysteria.

Robby's thoughts struck them again with physical force. He had given up an attempt at language and the images cascaded over them. The visual images were vaguely distorted, miscolored, and tinged with an aura of wonder and newness. Bremen and his wife reeled from their impact.

A WHITE ROOM. WHITE.
THE HEARTBEAT OF A MACHINE.



"Offhand, Professor Steinmetz, do you recall which was born in the Cameroons and which in the Washington Zoo?"

SUNLIGHT ON SHEETS
THE STING OF A NEEDLE
VOICES WHITE SHAPES MOVING
A GREAT WIND BLOWING
A CURRENT PULLING PULLING
PULLING

With the images came the emotional overlay almost unbearable in its knife-sharp intensity discovery loneliness wonder fatigue love sadness sadness sadness

Both Bremen and Gail were on their knees Both were sobbing without being aware of it In the sudden stillness after the onslaught Gail s thoughts came loudly *Why is he doing this? Why won't he leave us alone?*

Bremen took her by the shoulders Her face was so pale that her freckles stood out in bold relief

Don t you understand, Gail? It s not him doing it

Not??? Who ?????

Gail's thoughts rolled in confusion Splintered images and fragmented questions leaped between them as she struggled to control herself

It s me Gail Me Bremen had meant to speak aloud but there was no sound now only the crystalline edges of their thoughts *He s been fighting to keep us together all along I m the one I don t belong He's been hanging on for me trying to help me to stay but he can't resist the pull any longer*

Gail looked around in terror The fog boiled and reached for them in tendrils It was closing around the god figure on his mount Even as they watched his radiance dimmed

Touch him thought Bremen

Gail closed her eyes Bremen could feel the wings of her thought brushing by him He heard her gasp

My God, Jerry He's just a baby A frightened child!

If I stay any longer I ll destroy us all With that thought Bremen conveyed a range of emotions too complex for words Gail saw what was in his mind and began to protest but before she could pattern her thoughts he had pulled her close and hugged her fiercely His mindtouch amplified the embrace, added to it all the shades of feeling that neither language nor touch could communicate in full Then he pushed her away from him turned and ran toward the wall of fog Robby was visible as only a faint glow in the white mist clutching the neck of his teddy bear Bremen touched him as he passed Five paces into the cold mist and he could see nothing not even his own body Three more paces and the ground disappeared Then he was falling

The room was white the bed was white the windows were white Tubes ran from the suspended bottles into his arm His body was a vast ache A green plastic bracelet on his wrist said BREMEN JEREMY H The doctors wore white A cardiac monitor echoed his heartbeat

"You gave us all quite a scare" said the woman in white

"It's a miracle," said the man to her left. There was a faint note of belligerence in his voice. "The EEG scans were flat for five days, but you came out of it. A miracle."

"We've never seen a case of simultaneous seizures like this," said the woman. "Do you have a history of epilepsy?"

"The school had no family information," said the man. "Is there anyone we could contact for you?"

Bremen groaned and closed his eyes. There was distant conversation, the cool touch of a needle, and the noises of leave-taking. Bremen said something, cleared his throat as they turned, tried again.

"What room?"

They stared, glanced at each other.

"Robby," said Bremen in a hoarse whisper. "What room is Robby in?"

"Seven twenty-six," said the woman. "The intensive care ward."

Bremen nodded and closed his eyes.

He made his short voyage in the early hours of the morning when the halls were dark and silent except for the occasional swish of a nurse's skirt or the low, fitful groans of the patients. He moved slowly down the hallway, sometimes clutching the wall for support. Twice he stepped into darkened rooms as the soft, rubber tread of quickly moving nurses came his way. On the stairway he had to stop repeatedly, hanging over the hard, metal railing to catch his breath, his heart pounding.

Finally he entered the room. Robby was there in the far bed. A tiny light burned on the monitor panel above his head. The fat, faintly odorous body was curled up in a tight fetal position. Wrists and ankles were cocked at stiff angles. Fingers splayed out against the tousled sheets. Robby's head was turned to the side, and his eyes were open, staring blindly. His lips fluttered slightly as he breathed, and a small circle of drool had moistened the sheets.

He was dying.

Bremen sat on the edge of the bed. The thickness of the night was palpable around him. A distant chime sounded once, and someone moaned. Bremen reached his hand out and laid a palm gently on Robby's cheek. He could feel the soft down there. The boy continued his labored, asthmatic snoring. Bremen touched the top of the misshapen head tenderly, almost reverently. The straight, black hair stuck up through his fingers.

Bremen stood and left the room.

The suspension on the borrowed Fiat rattled over the rough bricks as Bremen swerved to avoid the streetcars. It was quite early, and the eastbound lane on the Benjamin Franklin Bridge was almost empty. The double strip of highway across New Jersey was quiet. Bremen cautiously lowered his mindshield a bit and flinched as the surge of mindbabble pushed against his bruised mind. He quickly raised his shield. Not yet. The pain throbbed behind his eyes as he concentrated on driving. There had not been the slightest hint of a familiar voice.

Bremen glanced toward the glove compartment, thought of the rag-covered bundle there. Once long ago he had fantasized about the gun. He had half-convinced himself that it was some sort of magic wand—an instrument of release. Now he knew better. He recognized it for what it was—a killing instrument. It would never free him. It would not allow his consciousness to fly. It would only slam a projectile through his skull and end once and for all the mathematically perfect dance within.

Bremen thought of the weakening, quiet figure he had left in the hospital that morning. He drove on.

He parked near the lighthouse, packed the revolver in a brown bag, and locked the car. The sand was very hot when it lopped over the tops of his sandals. The beach was almost deserted as Bremen sat in the meager shade of a dune and looked out to sea. The morning glare made him squint.

He took off his shirt, set it carefully on the sand behind him, and removed the bundle from the bag. The metal felt cool, and it was lighter than he remembered. It smelled faintly of oil.

You'll have to help me. If there's another way, you'll have to help me find it.

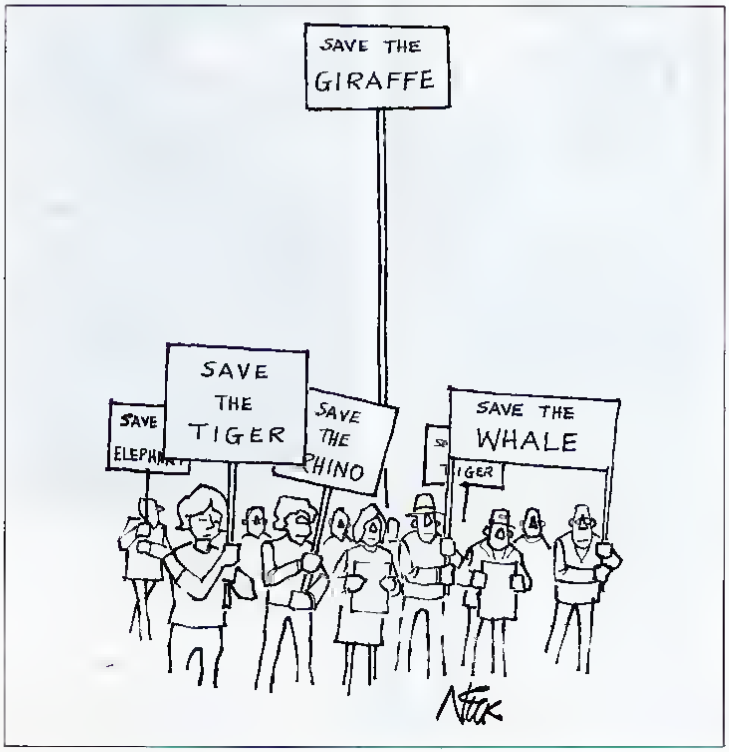
Bremen dropped his mindshield. The pain of a million aimless thoughts stabbed at his brain like an icepick. His mindshield rose automatically to blunt the noise, but Bremen pushed down the barrier. For the first time in his life Bremen opened himself fully to the pain, to the world that inflicted it, to the million voices calling in their isolation and loneliness. He accepted it. He willed it. The great chorus struck at him like a giant wind. Bremen sought a single voice.

Bremen's hearing dimmed to nothing. The hot sand failed to register; the sunlight on his body became a distant, forgotten thing. He concentrated with enough force to move objects, to pulverize bricks, to halt birds in their flight. The gun fell unheeded to the sand.

From down the beach came a young girl in a dark suit two seasons too small. Her attention was on the sea as it teased the land with its sliding strokes and then withdrew. She danced on the dark strips of wet sand. Her sunburned legs carried her to the very edge of the world's ocean and then back again in a silent ballet. Suddenly she was distracted by the screaming of gulls. Startled, she halted her dance, and the waves broke over her ankles with a sound of triumph.

The gulls dived, rose again, wheeled away to the north. Bremen walked to the top of the dune. Salt spray blew in from the waves. Sunlight glared on water.

The girl resumed her waltz with the sea, while behind her, squinting slightly in the clean, sharp light of morning, the three of them watched through Bremen's eyes. ◻◻



COMMUNICATIONS

CONTINUED FROM PAGE 10

about this questionable method of treatment I happen to be a student of psychology

Anyone with even a sparse background in psychology realizes that the diagnosis and the treatment of mental disorders usually takes more than just one session with a therapist and that the actual presence of the therapist is extremely important

Drs Cavender and Fischer take an alarmingly simplistic view of psychological problems by stating that eighty percent of people's problems centered on problem-causing beliefs " This idea does not make sense especially if one considers various types of schizophrenia and those mental illnesses that have some basis in biological causes

I found their answers to be vague and misleading and not very professional I question the ethics of such a practice that claims it can set one on the road to a happier life Perhaps the most revealing aspect of this article is that Anne Klein did not say whether the treatment was effective or not I would not be surprised if therapy by mail becomes another fad that will quickly fade away

James Watson
Warren, Mich

Unlucky Winner

I am honored that James Randi has used *Omni* [Last Word, May 1982] to give me his 1982 Uri Award for the "silliest statement made about the paranormal by an academic Given Mr Randi's passionate commitment to attacking anything that suggests that the psi abilities might be real his need to single me out for this award assures me that my research must be becoming more productive

The statement he attributes to me The prediction of any event becomes more difficult the more distant in the future the event is, is the opposite of what I said in a paper I read at the 1981 meeting of the Parapsychological Association

If elementary standards of competency were used by Mr Randi in giving his award such as being able to read correctly what someone has written in all honesty I would have to decline it Judging from his past performances though I'm sure Mr Randi was not too concerned with what I actually said when he selected me for his award So I can accept it with a clear conscience

I would prefer if Mr Randi shipped me my award " tastefully bent spoons each mounted on a cheap clear plastic base by parcel post rather than by teleportation

Charles Tart
Davis, Calif

Erratum

We mistakenly stated [Forum, June 1982] that Eric Siegel was the founder of Aesthetic Realism The name intended was Eli Siegel —*Ed*

Uh-oh

INTERVIEW

CONTINUED FROM PAGE 97

Omni: Then what was your discovery?

Bethe: Charles L. Critchfield and I calculated the actual rate in the proton-proton reaction Weizsäcker didn't do that. And I was convinced, after that, that this was *the* reaction. But that didn't fit the big and brilliant stars like Sirius. So, in an attempt to find an explanation for those, I found the carbon cycle. Weizsäcker discovered it at about the same time, but my theory was a lot more nearly complete.

Omni: You are one of the few people to win a Nobel for work in astrophysics. Why is that so?

Bethe: Well, the Nobel statutes were written in such a way as to make astronomers ineligible. I was the first exception, probably because I was also a pure physicist. My citation mentions not only the nuclear reactions in the stars but also my work on nuclear theory, in particular nuclear reactions, and still more exactly the nuclear reactions that are responsible for the energy in the stars. It first mentions nuclear reactions in general.

Omni: How did you learn of your selection in 1967, and what was your reaction?

Bethe: Because there is no prize for astronomy. I didn't expect it at all. One morning, at six o'clock, I was awakened by a telephone call. Usually a telephone call at that time means a wrong number, so I just let it ring for about, oh, two minutes. Then I lifted the receiver and it turned out to be a man from the Swedish TV network who said, "Well, I am instructed to tell you that you have won the Nobel Prize for physics." Then he read me the citation. He had hardly hung up the receiver when there was another phone call. One after another all the radio stations around the country called me to interview me. By that time I was awake. It happened that my brother-in-law was in the house and in bed, and he decided that war had probably broken out and I was being called from Washington to be told what to do!

Omni: Did your work that earned you the Nobel also lead to the initiation of research on controlled fusion?

Bethe: Certainly. But when I published my work on nuclear reactions in *Reviews of Modern Physics* back in 1936 and 1937, I never thought that engineers and physicists would pick up on it and start thinking about fusion reactions as a new energy source.

Omni: President Reagan's science adviser, George Keyworth, stated not long ago, "There is no doubt in my mind that fusion will work and will be the ultimate power source in the future." Would you care to comment?

Bethe: I am also optimistic about fusion. At this moment I am not optimistic about fusion's being used to generate commercial electric power. But I am very optimistic that fusion will make it possible to convert ura-

nium-238, which is an inert material, into plutonium in a very effective manner—and, likewise, to convert thorium, also an inert material, to uranium-233. I think this will work. It is the so-called fusion-breeder concept. And I do believe that, by the second half of the twenty-first century, this will probably be our most important source of energy.

Omni: Most people do think of using fusion to produce electricity directly. Why are you not so sanguine that this will succeed?

Bethe: I think it will succeed technically. But I don't think it will succeed economically for a long, long time. You want continuous operation of an electricity producer. For the first two decades or so that they operate, fusion-power plants may well have frequent interruptions—frequent downtimes. This would be a general feature of any complicated new plant, and a fusion plant will be far more complicated than a fission plant—about as much more complicated as is a fission plant, compared to a coal-fired boiler. Also the amount of energy produced in each fusion reaction is not very great. Each reaction gives an energy of only seventeen MeV—seventeen million electron volts. But if fusion takes place in the fusion breeder, then each reaction ultimately may give several hundred MeV—even a thousand MeV—because each reaction gives off a neutron, and when the neutron hits a nucleus of uranium or thorium, it can produce fissionable fuel. And then each fission reaction gives off two hundred MeV.

Omni: So the fusion breeder would act as an energy multiplier.

Bethe: That's exactly it. The fusion devices that are currently being worked on include the tokamak and the mirror machine. The tokamak is shaped like a torus [doughnut-shaped], while the mirror is a tube with magnets at each end. They are likely to put out only about as much energy as it takes to run them—maybe a little more. To do ten times as well will be an extremely hard struggle. Now people hope that a machine like the tokamak may lead to ignition, so that energy will not have to be injected into the plasma, but the fusion plasma will keep itself hot with its own reactions. If you reach that stage, then you are well off. But that stage is quite far away.

Omni: The tokamak dominates current fusion research. Do you see more promise over the long term in the mirror machines?

Bethe: The tokamak certainly is way ahead of everything else and is likely to be the first machine that will break even. It has a very convoluted geometry, and so it is quite difficult to operate and maintain and is particularly difficult to use in connection with a breeder. The mirror machine is less advanced. In its present version, it will not break even.

Omni: The Mirror Fusion Test Facility-B is currently being built at Lawrence Livermore Laboratory, in California. You do not believe that it will reach the break-even point sometime in the near future?

Bethe: That, I think, may reach break-even. To have a really good mirror machine, it is necessary to solve certain technical problems. The hot plasma in the long cylindrical part must be separated somehow from cooler plasma—the so-called warm plasma—at the ends of the cylinder. It is the warm plasma that is injected in order to prevent excessive plasma leakage. Well, this thermal separation is a very intricate process. But if it succeeds, I think it is likely that the mirror machine will be a better machine than the tokamak.

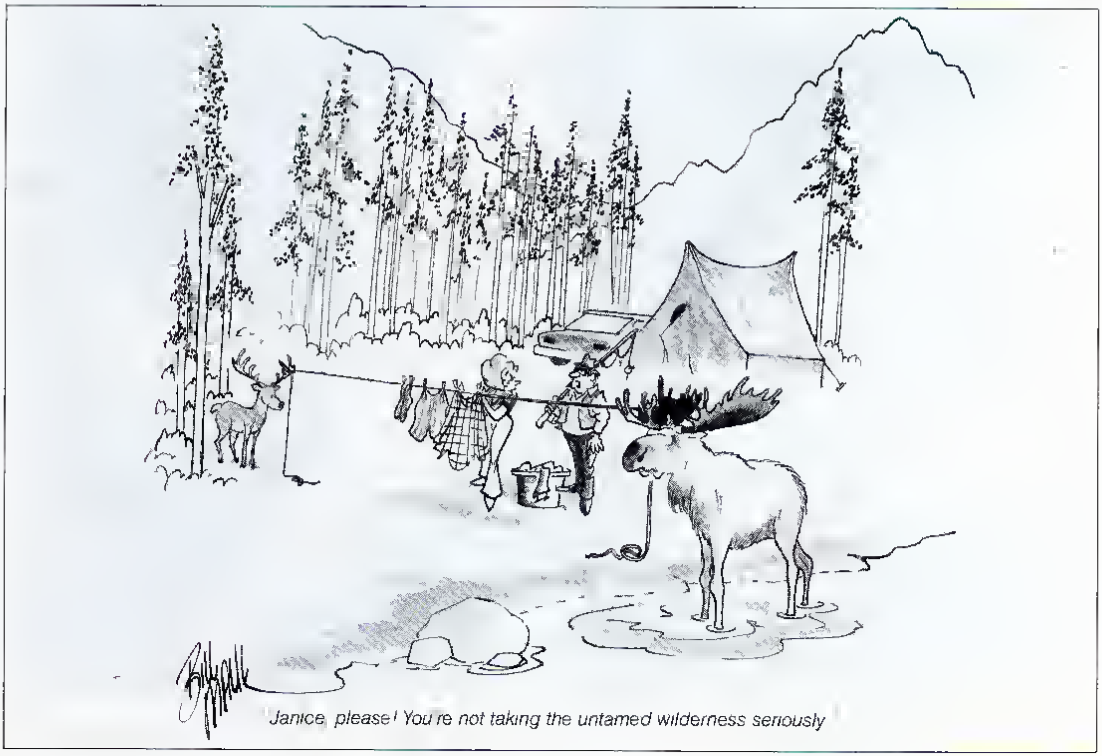
Omni: In San Diego, Robert Bussard has put together a company funded with venture capital. He is claiming that within a few years he can build a tokamak that will not only work, but will make money, too. What do you think of Dr. Bussard's efforts?

Bethe: Well, more power to him. I don't know what he is doing differently. I think making money from fusion is at least twenty, more likely thirty or forty, years away.

Omni: In addition to the mirror machine, there is what we call the field-reversed mirror. Does this offer greater promise?

Bethe: The field-reversed mirror is an old idea—a very difficult thing to accomplish. If certainly is further away than the plain mirror.

Omni: One advantage of the mirror is that it can sustain much higher temperatures than the tokamak can. Wouldn't this open



Janice, please! You're not taking the untamed wilderness seriously.

the opportunity for using advanced fuels such as

Bethe Deuterium deuterium Now you are talking about much longer time scales I was mentioning twenty to forty years before full commercial success with deuterium-tritium as a fuel Using deuterium deuterium, I should talk in terms of fifty to a hundred years Today, of course we are trying to work with the reaction between deuterium and tritium—hydrogen-2 and hydrogen-3 Tritium is not a naturally occurring substance You have to make it by letting the neutrons that come from the plasma interact with lithium Deuterium is a naturally occurring substance obtained from seawater through distillation or similar processes So you are much better off using only deuterium because you don't need to make it artificially That's a wonderful advantage The disadvantage, of course is that deuterium-deuterium requires a temperature five times higher than the temperature needed for deuterium-tritium to react And this temperature gets close to the energy level of the neutral beams that are injected to heat the plasma

Omni Would it be fair to say that the fusion technology of a century or two from now might be oriented toward field-reversed mirrors fueled with deuterium-deuterium?

Bethe Yes I think that is a good way to say it I would say that is a sensible goal

Omni If it will be so difficult to achieve economical energy generation then should we talk about using fusion to produce neutrons to breed fissile fuels? Obviously you believe that this is the way to proceed

Bethe It is the way to proceed as a first step in any case One possible way is a two-stage line of development Once the fusion breeder is going well you begin to develop direct electricity production from fusion with the machine that is used for the fusion breeder This fusion breeder would have a fusion reactor at the core surrounded by a blanket containing uranium or thorium

Omni A few years ago William Metz staff writer for *Science* wrote that such a fission-fusion-combined breeder would actually have all the complications of both a fission system and a fusion system and that this would necessarily be an exceptionally difficult way to go How do you respond to that criticism?

Bethe I think it is totally wrong The first idea it is true was to surround the fusion device with a blanket and make energy in that blanket This I regard as a bum idea It combines all the difficulties of both worlds The best idea that I know of is to surround the fusion system with a suppressed-fission blanket and try to keep the fissions in that blanket to a minimum This would require a minimum of cooling in the blanket and would avoid the troubles of fission I want to separate the fission and the fusion completely by operating the fusion breeder off-line from the power plants And I want the fusion device to make only material that is fissionable and that can then be used in a state-of-the-art fission reactor

Omni You are talking about fusion as a source of cheap neutrons which would be used to breed cheap plutonium How do you prevent all this from being used to make nuclear bombs?

Bethe My idea is that these fusion-breeder plants would be very heavily guarded and would be built in special locations They would not be run by the utilities which is an important point but by the government and the product would then be sold to utilities The reason why all this is possible is that one such fusion breeder would supply enough fuel for ten to twenty ordinary reactors Moreover I would prefer to produce uranium-233 rather than plutonium So the fuel would be produced and processed in the same closed location making it into low-enriched uranium That is the fuel that would be sold to the utilities None of the high-grade material would ever leave the site It would be a military site if you want It would be subject to that level of security

Omni When you produce fissile fuel within the fusion breeder you expose uranium to neutrons But you would like to have the resulting fuel to be useless for bomb making or out of the reach of terrorists Isn't it true that if the uranium is exposed to the neutrons for a sufficiently long time the resulting plutonium would be a mix of isotopes that would be lethal to any terrorist and would be useless as bomb material?

Bethe Yes, you could run it that way But it's a wasteful way to do it Plutonium-239 is the weapons-grade material Plutonium-240 actually is not lethal It does not emit any particular radiation that might kill a terrorist It just makes bad bombs But instead of exposing uranium to neutrons you could also work with the element thorium to make U-233 This has even greater advantages than making plutonium because U-233 automatically contains uranium-232 which strongly emits gamma rays Any person who stole that would indeed be severely irradiated But some of these procedures would be wasteful of the neutrons and might be an unnecessary precaution

Omni So by a combination of clever physics and military-type security you would expect to safeguard these materials to prevent their misuse? In other words have your cake and eat it, too?

Bethe Exactly Besides we have tons of weapons-grade material—in the form of weapons These are far more convenient for a terrorist to steal than just the material and we have continued to safeguard them successfully

Omni In 1974 using a Canadian-supplied reactor India built a bomb—something India was not supposed to be able to do Would these safeguards be sufficient to prevent anything like that from ever happening again?

Bethe What happened in India probably will occur again It is very difficult to completely prevent any accumulation of fissionable material for illicit purposes—that

is for making bombs. All we can hope to do is keep the amounts of material that are so diverted very small so that they don't make very much difference in the world picture.

Omni: Your picture of the twenty-first century then, is one of a world in which nuclear power from standard light-water reactors such as we have today will perhaps be the predominant energy source. What future Dr. Bethe do you see for the conventional fast-breeder such as the French Super-Phenix?

Bethe: I think it's a good reactor and the French have done extremely well with it. I wish we had done the same, but we haven't. It is the most straightforward way to get more fissionable material. There are two difficulties with this road. One is that when you have an expanding economy in fission the breeders don't breed new fuel fast enough to keep up. At the very best they produce enough new fuel for themselves for new breeders. The other problem is that breeders are likely to remain considerably more expensive than light-water reactors. There are people though who say that breeders ultimately will cost less than light-water reactors because breeders will be smaller and they'll be more compact. However, that's a long way in the future, if it ever happens. The average knowledgeable estimate is that the probable cost will be about fifty percent more.

Omni: In other countries, such as France, Japan, perhaps the United Kingdom, certainly the Soviet Union, nuclear power is being developed rapidly. Here at home, though, that development is being held back. Why should this be?

Bethe: The reason is economics and the availability of material. We have coal, lots of coal, and it is cheap. The price of coal is still less than forty dollars a ton here in the United States. In Germany it's one hundred twenty dollars per ton. The Germans and the British like to use their own coal, but there is very little of it, and it is tremendously expensive. For those two countries, the cost of making electricity from coal imported from the United States is about the same as the cost of making it from fission. The cost of electricity from domestic coal is nearly twice the cost of making it from fission.

Omni: Isn't it true that South Africa, which has abundant and particularly cheap coal, is building nuclear-power plants?

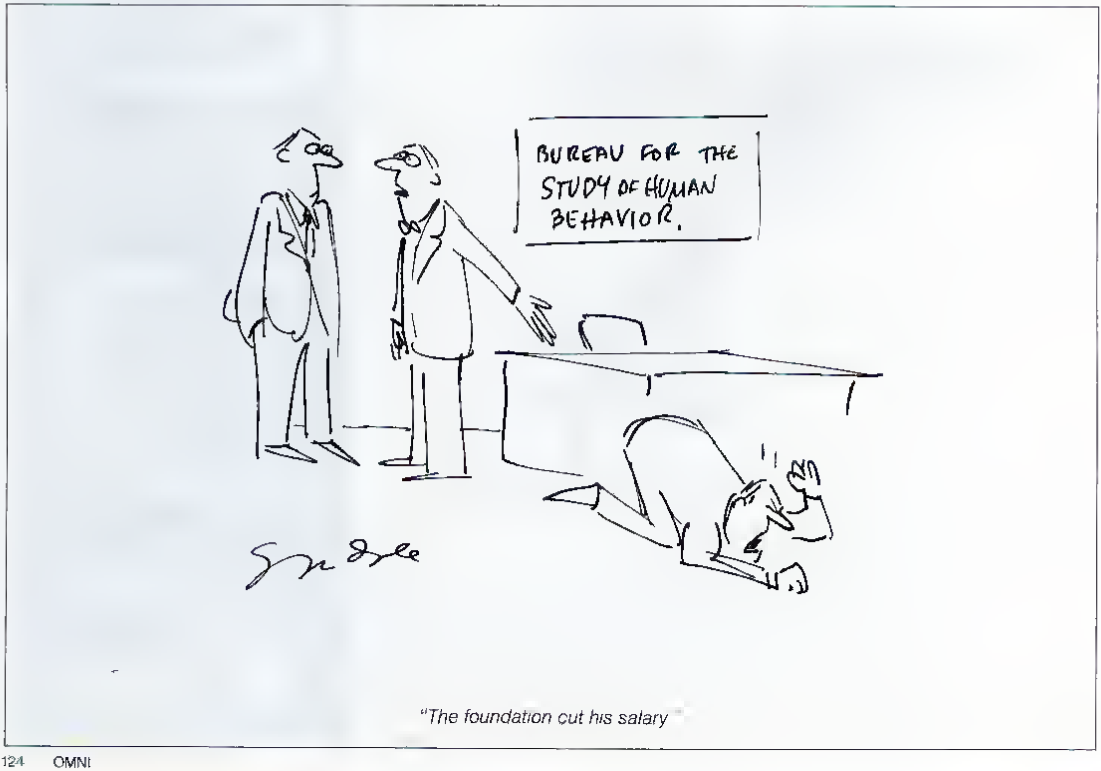
Bethe: I am afraid I have to attribute nefarious intentions to the South Africans. I would believe that they are very much interested in nuclear weapons, not only in nuclear power. So that country's a special case. But the United Kingdom and Germany are typical cases, and other typical cases are France, Japan, and Italy.

Omni: Is the regulatory or legal climate that affects the construction and operation of nuclear plants different in France or Japan from what it is in this country?

Bethe: I don't know about Japan. The French regulatory climate is a great deal different in that the government has very strongly supported the building of nuclear plants. In this country, I think this has no longer been the case since 1972 or so. It is true that the U.S. government did build some demonstration plants during the 1950s and early 1960s. The same has happened in France and Japan and certainly in Britain. But one should remember that in this country the main investment of money did not come from government but from private industry. It takes an enormous amount of money to translate blueprints into a plant that actually works reliably. And the big companies—Westinghouse and General Electric—and also the smaller companies have invested. I am quite sure billions of dollars to come up with a reliable product. So what the government did was only to prime the pump.

Omni: We actually have two classes of nuclear reactors in common use in this country. Far less well known than the power plants with their cooling towers, which one sees on the nightly news, are the nuclear plants used in naval submarines and other vessels. How would you compare the safety and performance record of the naval reactors with the civilian ones?

Bethe: We do know that no submarine ever blew up because the reactor malfunctioned. I think we know that there has not been a meltdown accident in a subma-



"The foundation cut his salary."

rine—probably not even a partial one The submarine reactors have extremely good qualify control in every detail And the Navy is willing to pay very high prices for these reactors In my opinion quality control—excellenf quality control—should also apply to the civilian reactors And I feel that this could be improved The regulatory climate should shift in the direction of improving quality control

Omni Do you believe that for the sake of quality control the Navy pays relatively more per installed kilowatt than civilian plants do?

Bethe I am sure they pay much much more than civilians

Omni So then in order to meet economrc criteria civilian plants must necessarily pay somewhat less attention to quality control than the Navy does

Bethe I'm not sure Probably somewhat less that's true But civilian power plants have one great advantage They are big Because they are big the cost per kilowatt will automatically be less even with the same amount of quality control The typical naval reactor is maybe fifty megawatts and the fypical civilian reactor is a thousand Now I have high hopes for INPO—the Institute for Nuclear Power Operation—an organization created by the nuclear industry after the Three Mile Island accident One of its several functions is to supervise the building of nuclear reactors Another is to look after the safe operation of nuclear-power plants And I think that's an extremely important point Some utilities are very good and some are not so good INPO is trying fo raise the quality of operation by giving information fo all the individual utilities and also by having its own people go around to see whether the operations are completely up to standard So in a way they constitute a second Nuclear Regulatory Commission

Omni The industry's own organization

Bethe And therefore much more acceptable to the industry Then further they are dangling a carrot—a mutual insurance fund in case of accident As you know in the case of an accident like the one at Three Mile Island the most expensive thing is the replacement power

Omni Meaning that when the plant shuts down the utility must buy power from the outside

Bethe And much of that is made from oil So the industry decided to have a pool from which they would subsidize a ufility that had an accident both to clean it up and to buy the substitute power but only if the utility conformed in every way to INPO's rules of maintenance

Omni Here in California the Diablo Canyon and San Onofre plants have had problems because of the public's concern about seismic hazards Japan is subject to a great many earthquakes and yet Japan has a very strong nuclear program which has built a large number of plants What can the Japanese teach us about seismic hazards?

Bethe We know quite well how to protect a plant against seismic hazards It costs money The requirement at Diablo Canyon is that the plant should be able to withstand an earthquake of magnitude 7 5 The San Francisco earthquake in 1906 was magnitude 8 3 But I believe that beyond 7 0 or so the rise in magnitude increases the area that is shaken but does not substantially increase the accelerations—fhe ground-shaking—at any one place So yes I think it would be significant if the public were aware of Japan as a nation that is very subject to earthquakes and that is also proceeding with a very vigorous nuclear program It might be interesting to find out what the Japanese do about the problem The great strength of Japanese industrial activities is their beautiful attention to detail So I am sure that they do it right

Omni Quality control has indeed been a major problem at the Diablo Canyon plant

Bethe Exactly and that worries me For the past five years or so no new orders for power plants have come in I don't believe that this situation will last forever I imagine that maybe in another five years or so the climate will change and new orders will come in

Omni Suppose that nuclear plants be-

come economically attractive again. It is possible that the utilities will have been so burned by their past difficulties that they will be reluctant to move in that direction. Might another round of governmental pump-priming then be in order?

Bethe: I can think of only one respect in which that might be useful, that is, to develop still-safer designs. For instance, one design that is ultrasafe but unfortunately also quite expensive is the gas-cooled, high-temperature graphite reactor. One is already operating at Fort St. Vrain, in Colorado. It had a lot of bugs for a long time, but I think the bugs are exterminated. In principle, I think this design is just unbelievably safe—far safer than a coal-fired plant. I would say. It is cooled with gas. Gas cannot boil, it's already gas.

Omni: In other words, when water boils, the core can be uncovered, resulting in a meltdown. But that cannot happen if gas is used.

Bethe: Correct. Another factor is the enormous heat capacity of these reactors. If something goes wrong, the operators have a very long time to respond. They can take the time to do it right; they don't have to panic and rush for whatever is at hand.

Omni: If nuclear enterprise is revived in this country, do you think it will stimulate a move to standardize such plants, or will it continue to push ahead with light-water reactors of conventional design?

Bethe: Very likely, light-water reactors.

Omni: Even though the gas-cooled graphite reactor design is much safer?

Bethe: It is safer, but how much do you pay for more safety? The light-water reactor is very safe itself.

Omni: In Germany, the *Atomgesetz*—the Atom Law—requires that safety take precedence over all other considerations, even economic considerations, and that no effort be spared in order to ensure that safety has been pushed to the limit. If we adopted such a law in this country, would that influence the choice between light-water versus gas-cooled reactors?

Bethe: I think it probably would. I think it's a stupid law. It could greatly force up, even double, the cost of our energy. And that could begin to be intolerable.

Omni: You obviously have a rather different view of reactor safety than many influential people have. Why do you feel as you do?

Bethe: Because I consider safety to be a matter of numbers. I consider everything to be a matter of numbers. The question is, what are you likely to buy with further increases in safety? At current safety levels in our nuclear industry, I would anticipate an average of two fatalities per year. A major accident, which has not happened, might occur once in a thousand years. I define a major accident as one in which large amounts of radioactivity are vented on the public. In such an accident, the estimate—and I think it a very sensible and good estimate—is that one thousand people would die from delayed cancers. Of course, it's not certain at all that anybody would die from delayed cancers. But going by present assumptions, that's a thousand deaths every thousand years. That's one a year. I add to this the possibility that such a major accident could occasionally be coupled with very bad wind and rain conditions, which would increase the number of fatalities, because some of the radioactivity might fall out very close by on a populated area. This is all in the Rasmussen Report [a 1975 study on nuclear safety]. For that reason I double the rate. That's two per year.

Omni: For how many reactors is that?

Bethe: For one hundred reactors, for one thousand years.

Omni: So if we had a thousand reactors, we could expect on the average twenty deaths per year.

Bethe: Twenty fatalities per year. Compare this with the statistics on drunken driving. Half of all our traffic deaths are due to drunken driving. We could reduce the number of deaths caused by auto accidents by twenty thousand per year if we were absolutely rigorous in preventing drunken driving. But in our society we tolerate this. We don't lift the licenses of drunk drivers or put them in jail.

Omni: What would you say then about the

attitudes of antinuclear activists who cite the safety issue?

Bethe I think they are confused There was an article in the February 1982 issue of *Scientific American* that ranked a long list of risks that cause fatalities ranging from smoking, alcohol and automobiles at the top to power mowers and high-school football at the bottom And nuclear power ranked just above high-school football and a little below commercial aviation, which as we all know, is very safe And the author has still overestimated the danger of nuclear power probably by a factor of ten And that article also contained a list ranking the perceived risks as reported by a poll of college students and of members of the League of Women Voters And nuclear power was right at the top—more dangerous than handguns, more dangerous than autos or smoking Now the League of Women Voters are well-meaning people and on many political issues they are extremely sound But in their estimate of the dangers of nuclear power, they are just totally off the mark They are not extremists in any way they are simply confused

Omni Do you think public opinion will change in this respect?

Bethe Yes I think so And then the nuclear industry will be able to move ahead

Omni If that happens, we *may* wind up with a great deal of electric power—even a surplus of electricity Some people have proposed that surplus electricity could be used to produce hydrogen as a replacement for natural gas and perhaps even for automotive gasoline

Bethe Certainly natural gas will be the first that could be replaced I am rather optimistic that our natural gas will last a considerable time—much longer than oil certainly much longer than domestic oil But ultimately it'll have to be replaced Hydrogen certainly is a very sensible replacement The question is one of safety People assure me that hydrogen can be transported and used as safely as methane—as natural gas I don't know how well-founded this assurance is It may be entirely right and in that case we will get to the hydrogen economy sometime

Omni You hold out more hope for nuclear than for fossil fuels Could you comment on synthetic fuels?

Bethe There are two energy problems One is getting enough total energy which we can obtain from nuclear power or coal and the other is getting enough liquid fuels We cannot drive our automobiles with electricity—at least not very well We cannot run our airplanes with electricity and I think that will remain true for a long, long time We need liquid fuels for that And I strongly believe that oil will run out in spite of the current glut So I think we are going to need synthetic fuels

Omni One extremely active area of physics research nowadays is the search for unified-field theories What do you think are the prospects of success?

Bethe Well it sounds completely fantastic right now There are very competent people involved in it—some of the best University of Texas physicist Steven Weinberg for instance and many others There is quite a big group working on it here at Caltech But I think they are very far from having a theory

Omni So the fact that they have produced the electroweak unification theory linking the nuclear weak force and the electromagnetic force gives hope but not necessarily a path to follow

Bethe Correct A unified-field theory—which must also include the strong force and what is most difficult of all the gravitational force—well it seems just an enormously more difficult task than the electroweak unification

Omni As for testing the predictions of the electroweak theory that very heavy particle—the intermediate vector boson—has not yet even been found What if we search for it and don't find it?

Bethe But I think we will And I think that is the next likely great event in particle physics I am very confident that it will be found at approximately the energy level at which it is predicted to exist—some eighty billion electron volts

Omni Ever since Paul Dirac suggested it in the Thirties physicists have been proposing that physical constants—the constants of nature—change with time perhaps increasing or decreasing to follow the expansion of the universe What do you say about this?

Bethe There is something very interesting about this You probably know about the discovery of the West African natural nuclear reactor in which a deposit of uranium ore buried in the ground sustained a fission chain reaction some two billion years ago Now the interesting thing is that the ratios of isotopes among the fission fragments are exactly the same as the ratios in the fragments produced by our nuclear reactors today We are talking about resonances—precisely defined energy levels in the atomic nucleus These resonances involve energy levels of ten million electron volts And if one resonance is shifted by one tenth of an electron volt the ratio of the number of isotopes is completely changed So if the strong nuclear forces cannot have changed by as much as ten parts in a billion in 2 billion years then their physical constants are changing by no more than about one part in a million trillion And that is ten million times more slowly than the rate of expansion of the universe So what we learn from this constancy of the isotope ratios is that these physical constants themselves do not change at all even though the universe continues to expand

Omni One final question Dr Bethe What kind of work in astrophysics do you think would suffice to win another Nobel Prize?

Bethe Perhaps if someone could more definitely prove theories about the formation of galaxies and stars and about cosmology that might do it But for me, I think one is enough ∞

SPACE

CONTINUED FROM PAGE 20

much meteoroid damage they can take." It is a critical question. *Spacehab* would stay in orbit for 20 years or so, constantly sandblasted by space debris. Extra shielding for the aluminum outer walls could come in the form of meteoroid bumpers—rings of tanks holding water or even waste. The balloons "can also be easily patched from inside," Bell observes.

It is inside the balloons that the architects encountered the real difficulties of space design. Learning to live and work in orbit, to keep track of little items that drift away and papers that float off tables, will not be easy for space workers who have learned their every gesture in the presence of gravity. Trotti speculates that "it might be feasible to arrange some work areas as partially enclosed bubbles, each with its own ventilation filter to catch stray objects, its own light source, and a foot restraint to anchor the worker, since chairs will be unnecessary."

Vacuum-suction tablefops might hold papers down. Clamps, magnetized tools, Velcro-lined tool kits, and Velcro-handled fools are also possibilities.

To avoid the jack-in-the-box effect, in which contents float out of tightly packed drawers every time they are opened, Bell's group has designed transparent plastic drawers divided into numerous self-enclosed compartments so that people can see what they need and get it without disturbing the drawer's other contents. Similarly, bungee cords might restrain items in drawers on work surfaces, or against walls.

Of all space workers, physicians may have the greatest difficulty adjusting their skills to zero gravity. "For instance," says Dr. Daniel Woodard, a Houston physician who has consulted with the *Spacehab* group, "when you open the abdomen, the bowels would rise up, and it may be hard to put them back after surgery."

Medical equipment that depends on gravity, such as intravenous-feed lines and surgical drapes, will have to be redesigned. One item, digital X-ray scanners, may actually work better in space. "Because the patient can easily be rotated through the X-ray beam," says Woodard, "it may be possible to get a sort of CAT-scan image impossible to obtain on Earth with the same equipment."

On *Spacehab*, the operating table would be adjustable to a wide variety of positions, with the surgeon fixed in place and the patient moving around him—just the opposite of earthly practices. "In order to keep the patient sterile," Woodard notes, "it will also be essential in space to have a continuous air flow to carry any contaminants away."

Living areas could be even more disturbingly unfamiliar, so the architects took special care to make them as comfortable as possible. The dining-room tables will contain tray holds, foot restraints, and a rail along the outside to keep diners from bumping into one another. Some diners may find it a little disconcerting at first to look at their plate and see the soles of another diner's shoes. But "one of the great things about weightlessness," says Gerald Carr, senior consultant for Applied Research, Inc., and former commander of *Skylab IV*, "is that once you become accustomed to it, it's fun. You learn to reorient yourself to the lack of gravity pretty quickly."

And Clinton Rappole points out that good food is always a morale booster. Brunches, holiday buffets and "ethnic evenings" may break the monotony of cafeteria eating. Food will be prepared in commissaries on Earth and kept fresh by aseptic packaging and freeze-drying. Alcohol will almost certainly be forbidden, as it is now in space, on oil rigs, and in other isolated and perilous environments. "It's not the one glass of wine that's the problem," Rappole says, "but the fact that it would have to be stored in large amounts, causing a security problem. People devise ingenious methods to get at limited liquor supplies."

> *"The group has never managed to design a successful recreation area, because it's hard to know how space workers will want to spend their free time."*

Showering would be a messy, tedious necessity in a weightless environment. Trotti conceives of it as a kind of combination car-wash and health-club routine. "You could strip off your clothes in a locker room and put them in a washer-dryer to be cleaned," he suggests. "Then you would proceed to a tightly sealed sauna to relax or go directly to the shower room. Each shower stall would have a nozzle to spray the water, a sponge to remove most of it from the body, and a vacuum device to collect excess water on the walls for recycling.

"Then you would go to a drying room. This would contain sunlamps to stimulate production of vitamin D in the skin and to preserve a healthy look. Blow-drying could remove the rest of the moisture. At the end, you would return to the locker room to pick up your clean clothes. The whole routine would take about forty minutes."

In the gym, Bell's group took full advantage of zero gravity, mounting isometric exercise equipment on walls, ceilings, and floors. Since all *Spacehab* residents will have to exercise an hour or two a day to keep in condition to return to Earth, bicycle ergometers and advanced treadmills will also be standard equipment. Maynard Dalton, a spacecraft designer at NASA's Johnson Space Center, also advises setting aside a large open area for space acrobatics and new zero-gravity team sports. "It won't do a bit of good for conditioning the body," Dalton says, "but it should be a whole lot of fun."

The designers briefly considered adding a scuba diving pool to make exercise more pleasurable. "It would be great to locate the recreation- or dining-room windows so people could relax and watch the divers," Trotti says, "but we abandoned the idea because it would take up a thousand gallons of water, and we're straining to recycle every ounce."

He confesses that the group has never managed to design a successful recreation area, because it's hard to know how space workers will want to spend their free time. Some designers speculate that the prime rec room in space will be the bedroom. One points out that the personal computer terminal will be a combination window, TV, mailbox, library, telephone, tape recorder, video game, and correspondence course classroom. Another designer envisions more traditional activities, "though it'll be a pretty tight squeeze in the tiny bedrooms."

Writing poetry, composing music, drawing, and of course photography could all help buoy the residents' spirits. "I call it preventive creativity," comments Patricia Musick Carr, a psychology professor at the University of Houston who conducts a seminar in value systems on future space colonies. "Creativity is conditioned out of us at an early age, but it's an outlet, an important safety valve."

Many will keep diaries, as *Skylab* commander Gerald Carr did on his 84-day mission. "A diary has therapeutic value," he says. "But besides that, I felt I owed it to myself to capture this unique experience. I wrote about how the day went, how I was feeling, and several special things, like my first zero-g dream.

"Until day fifty," he explains, "all my dreams were one-g, in which I was walking or moving in one g. In zero-g dreams, I floated from place to place. My subconscious let go of Earth."

Although *Spacehab* could fly by the year 2000, it is still no more than a theoretical design. It will have to be redone later, with more careful attention to engineering limits and advanced building materials. But Bell's group has looked at space-station design with the eyes of architects who know that spatial relationships help to govern human relationships. It is an important first step.

"We addressed problems that will have to be solved whenever the time comes," Trotti sums up. "I'm convinced that good design can help offset psychological problems." OO

GAMES

ANSWERS TO GAMES (PAGE 144)

trick is to let only part of the body snake over the bar at any one instant. Schematically with the dot representing CG it looks like this.

3 BUBBLES. The small bubble has more internal pressure than the larger one, so it will shrink as the larger bubble expands. The same principle explains why a balloon is initially hard to inflate, but becomes easier as it expands.

4 SIREN. The speed of sound remains at 740 mph. It does not get an extra "push" by approaching you. The sound waves will be crowded closer together, however, resulting in a higher pitch, known as the Doppler effect.

5 WATCH OUT. The cork is still at the bottom. The bucket, water and cork all fall with the same acceleration and do not alter their relative positions while falling.

6 CANNONS. Surprisingly, no matter how far apart the cannons are or at what angle they aim at each other, the balls will always collide in flight. If there were no gravity, the missiles would meet midway between the two cannons. With gravity, the balls fall below this point by equal distances, so they will still collide in midair.

7 GUNS. The 45° angle of classical mechanics assumes negligible air resistance. Artillery shells fired at a steep angle may go up 25 or 30 miles, into the stratosphere, where the rarefied air offers little resistance, allowing the shells to travel many times farther.

8 BIG BRIDGE. The smaller bridge is twice as strong. If a steel girder B is twice the size of girder A in every dimension, it will be twice as strong as girder A, but it will weigh *eight* times as much. The double-sized bridge could be so weak that it would collapse under its own weight.

9 BIG BOATS. Neglecting their weight, big sails are just as strong as small ones. The reasoning of the previous problem doesn't apply in this case, because as the size of a sail grows, the force of the wind against the sail grows at the same rate.

This is an example of why physicists are so fond of the words *neglecting* and *roughly*. In practice, the weight of the sail has to be taken into account, also, winds 20 feet up may be a bit faster than winds only 10 feet up. So in practice a large sail must be made of stronger fabric than a small sail. The point of the question, in contrast to the previous one, is that the load on a sail (in the form of wind pressure) does not increase as the cube of the linear dimension, as load does on a bridge (in the form of weight).

10 COLD COMFORT. The pressurized cabin in an airliner keeps air compressed to sea-level pressures. At a high altitude this would raise the cabin temperature to 130° or higher if air conditioners were not used to extract heat from the air.

11 FULL BRIGHT. When sunlight strikes the moon from the side, as in a quarter moon, craters and other irregularities on the surface cast shadows that cut down on the total light reflected. At full moon the sun's light shines from directly above most of the lunar surface.

12 METEORS IN THE MORNING. As the earth passes through a swarm of meteors, its "face"—that is, in the direction the earth is traveling around the sun—encounters more meteors than its "back" does. For a similar reason, when you run through the rain, more water falls on your face than on the back of your head. In the early evening you are on the trailing side of the earth and the only meteors you will see are those that "overtake" the earth from behind. Between midnight and sunrise you are on the earth's face and are looking in the direction from which most collisions come. The phenomenon is the same in Australia and everywhere else on Earth.

13 BUCKETS. The bucket's fill at the same rate. While the cross-sectional "target" decreases, the rain's velocity increases just enough to offset it. The vertical component of the raindrops' velocity is not altered by the wind.

14 SAIL AWAY. Strange as it seems, the fan will propel the boat—*backward*. The reason is that not all of the wind generated by the fan is caught by the sail. The forward action is not enough to counter the backward reaction, so the boat is propelled backward.

15 MARS. A mountain cannot rise above a certain critical height, which on Earth is about 90,000 feet. A taller mountain would be so heavy that its base would turn into a liquid under the enormous pressure, thus causing the mountain to sink below the critical height. On Mars the gravitation is less, and so the mountains are lighter and can tower to much greater heights.

16 FLAG FALLACY. The flags show a star shining between the horns of a crescent moon. Since this area is merely the unlit portion of the moon, any stars that might be in that part of the sky would be hidden from view.

17 WHERE AM I? Try to spin one of your coins on the floor of your room; the coin will refuse to spin. By conservation of angular momentum, a spinning object tries to maintain its position in space. Since the spinning station is continually changing your position in space, a coin that is spun will keep changing its orientation to correct its angular momentum, and will topple and fall.

18 LADLE. Won ton. This is what is known as physical humor.

Next month: The World's Hardest Cube Puzzle (so far), and *Omni*'s Fourth Anniversary. ☒

BODY

CONTINUED FROM PAGE 24

Christy says, is cloak inexperience and bumbling with an air of sophistication and competence. Even more important, it hides the inability to make firm diagnoses. Such phrases as "schizophrenic, but with lucid intervals" and "not suicidal, but may harm self if left unattended" translate as "yes, but no." Catchwords hint at learning while giving even greater leeway. "The patient was essentially afebrile" means that the doctor was not sure whether the patient had a fever. And Medspeak's love of the passive tense—as in "The patient was explored"—protects the doctor from intimate contact with the patient.

Christy's search for the reason why Medspeak catches on so tenaciously led him deeper and deeper—"like peeling back the layers of an onion," he says—back to the medical student's first physical exam. "There you are in your first encounter with a half-naked patient, actually touching someone," he explains. "It brings up all sorts of fears about sex, parents, self-image, invasion of privacy, identification with or failure to identify with the patient. 'Who am I to be doing this?' you ask yourself. Then your interest mounts, and you think, 'My God, there's something to be found out here.' A bond forms between you and the patient, and you realize very plainly that you care."

But many doctors never make the final connection. For them, Medspeak is a weapon that fends off intimacy with patients, shielding themselves from the need to confront sickness, suffering, and death. Says Christy, "For them, medical cant is more than pomp and pedantry. It is obscurantism, a deliberate withholding of knowledge."

Hospitals and medical schools do recognize this problem. Some have set up writing courses; others have hired social workers to help residents learn to deal openly with patients. Sometimes they make videotapes of consultations with patients to help doctors see what they are doing wrong; in one I've seen, the resident never once looked at his patient.

"This isn't something you teach," Christy contends. "Its roots extend way back to the lack of a nurturing mother." He says that his only hope in such cases is that the worst offenders choose a "technologically oriented specialty like radiology, where you usually don't have to deal with the whole patient."

Yet communication is a two-way street. We may not be able to change our doctor's inner nature, but we can keep talking to him, keep trying to make him understand, and keep challenging Medspeak. If the doctor can translate such phrases as "benign lymphatic hypertrophy" into English, we will learn what they mean. If he cannot, we might just learn something that's even more important. ☒

The Artist

CONTINUED FROM PAGE 22

in making forecasts. It seems that the frontal brain is what detects our prediction needs. For example, a car is rapidly approaching. Will it turn right, left, or try to hit us head-on? The frontal brain alerts its "lieutenants," relevant left- and right-brain areas, to process in a ferocious hurry all the available information on this problem and provide their widely differing kinds of special reports. It then scans for brain-half agreements and disagreements, and decides what most likely will happen and what to do about it. (Turn left, turn right, or get ready to jump!)

To explore and substantiate this model I first developed a simple new paper-and-pencil test called the HCP Profile, or Hemispheric Consensus Prediction. HCP is essentially a multipurpose test of whether a person predominantly uses his right or left brain or both equally in forecasting as well as in other kinds of thinking. I have given this test to a variety of people including students at UCLA, Berkeley, and the Naval Postgraduate School at Monterey, California; executives from insurance companies throughout the United States and Canada; and a variety of people in the movie and television industries—writers, producers, actors, and actresses.

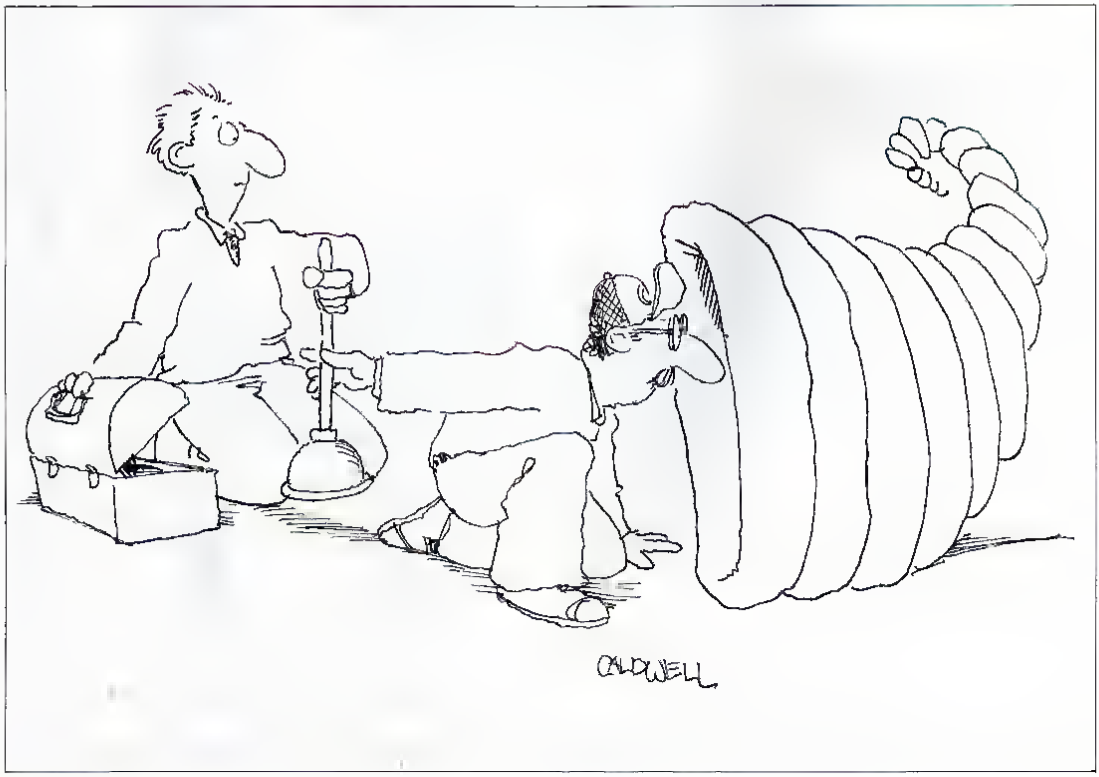
In one set of experiments I asked for predictions in politics, economics, and foreign affairs. Questions included: who would win the presidency in the 1980 election; whether inflation and unemployment would go up or down; whether there would be more or less fighting in the Middle East; whether Iran would return the hostages before election time; and whether another Great Depression was likely. People who tended to draw upon both brain halves equally—who have, in an important sense, balanced minds—turned out to be better predictors than those who are more exclusively right- or left-brain dominant.

A later experiment, done in 1979 with people in the movie industry, also bore out this balanced-mind concept in an interesting way. I found that writers, producers, and studio executives were unconsciously using two kinds of forecasting models in the early stages of production in order to predict whether the millions of dollars spent on a film over the next two or three years would pay off when it was finally released. Both right-brain and left-brain types talk about "flying by the seat of their pants" in making predictions, but they had very little understanding of how they do it. The more logical left-brain types would weigh such concerns as the audience for the film, how it would be marketed, the time involved in producing the film, and the timing of its release. Right-brain types considered some of these factors but weren't as clear in distinguishing the artistic value of the movie from its marketing. Instead of the mathematical-formula approach of the left-brain types, the more artistic right-brain types simultaneously thought about aesthetic and commercial factors, giving their prediction models the look of a spiderweb of tensions.

Using complex statistical analysis, I took the insights of people in the industry—from a group that included individuals like Alan Alda and Carol Burnett—and combined and studied their insights. The more they agreed, my theory went, the greater was their chance of being right. Out of this study came a configuration of the kind of film the group thought was going to be the new hit genre: the adventure movie. Although adventure films were not going anywhere in 1979, the next two years saw two, *The Empire Strikes Back*, in 1980, and *Raiders of the Lost Ark*, in 1981, move into the ranks of the superhits.

The final implications of these studies are that not only can the big think-tanks which routinely grapple with problems of national and global scope sharpen their predictions, but we can make more accurate predictions about events in our own lives as well.

Because this science is still in its infancy, the truly dazzling benefits of the gift of prophecy are yet to come. ∞



BOOKS

CONTINUED FROM PAGE 34

This contains no fewer than 332 questions to ask your computer salesman ranging from "What guarantees come with the software?" to "Do the keys click?" "Is the screen made of nonglare glass?" and other topics that are equally practical but that you otherwise might not consider until you've made an irrevocable buying decision.

This handy little book also contains a glossary of computer terminology, but the definitions are brief. You'll find a more thorough approach, proceeding step by step through the jargon, in *Your Own Computer*, by Mitchell Waite and Michael Pardee, for $7.95, from Howard W. Sams and Company of Indianapolis. (Sams is already famous for its many books on amateur electronics.) This is the best introduction that I've seen explaining what computers are and what they will do. It supplies specifications for most popular brand names with the exception of IBM, Osborne and Xerox, whose personal machines appeared after the book was completed.

Once you've absorbed this guide, you should consider learning a little about programming. You may think you're not good enough at math to be interested in writing your own computer programs, but programming uses logic rather than math, and the most unlikely people can acquire a taste for it. To get some idea of whether you're one of them, you could read a copy of *Why Do You Need a Personal Computer?* by Lance A. Leventhal and Irvin Statford ($8.95, from John Wiley and Sons, New York). This is not terribly well organized but is easy to understand.

Or try *Computer Literacy*, by Cann E. Horn and James L. Poirot, from Sterling Swift of Austin, Texas. This is intended as a high-school textbook, but it's easy reading and describes the history and theory of computers in addition to the art of writing programs.

These books in particular will help you understand what computers are all about, whether you could use one, and what it would do for you. On the other hand, if you remain a skeptic, or if you don't want to spend the money right now, there's a book for you, too. *Computer Choices*, subtitled *Beware of Conspicuous Computing!*, by H. Dominic Covvey and Neil Harding McAlister ($8.95, Addison-Wesley). This book debunks the whole computer fad with case histories of small businesses that went bankrupt after computerizing and of private users who bought home computers, couldn't find anything useful to do with them, and abandoned them to gather dust in the attic. This book is the perfect gift if you're the parent of a whiz kid whose hunger for hi-tech exceeds your disposable income. At $8.95, it's not a particularly cheap paperback, but if you're looking for excuses to *avoid* buying a home computer, it could be a bargain.

FOR FUTURE REFERENCE

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FORUM

CONTINUED FROM PAGE 12

tion's policies do not seem to support the President's rhetoric with respect to the government's responsibility to demonstrate the scientific and engineering feasibility of fusion.

It may just be that this administration is composed of too many men of narrow vision who are unable to see beyond the dollar bill. Compounding this problem is the awesome influence of big oil companies and the nuclear-power industry. I suspect that neither would favor fusion power, which may be considerably cheaper than burning oil or using nuclear fission.

Phillip Cutler
Costa Mesa, Calif.

Star War

In *Omni*'s May 1982 issue I came across an article in the Antimatter section entitled "Star Wars." The article dealt with a recently discovered void in space 300 million light-years in diameter, the largest void yet discovered.

Since *Omni* is a magazine of science, one would expect scientific explanations for the void to be presented. The only explanation offered, however, was not only nonscientific but also ludicrous.

John Schuessler claims the only feasible explanation for the void would be an interstellar war between supercivilizations that resulted in the "liquidation" of galaxies. The idea of a war between two separate civilizations is in itself unlikely. Chances are that one civilization would be more advanced than the other and would have an insuperable advantage.

I also doubt that the destruction of one or even several solar systems can result in the destruction of galaxies. A supernova, the explosive death of a giant star, often occurs without such adverse effects.

Schuessler also implies that we have the capabilities today to destroy the earth and that such an event would lead to a similar catastrophe. This idea is ridiculous. The moon itself might survive an explosion of the earth and fall into stable orbit.

Even if Schuessler's hypothetical galactic "liquidation" did occur, the exploding galaxies would have spewed out copious amounts of matter and radiation that would still be visible to astronomers today. The explosion would hardly result in a void. Matter does not simply cease to exist without a trace.

Schuessler confesses that "it is pretty difficult to come up with an explanation more believable than interstellar war," unless of course you want to try a scientific explanation, which he has clearly ruled out. Astronomers know that galaxies are not spread evenly throughout the heavens but occur in galaxy clusters bound together by gravitational force. Since these galaxy clusters are also moving away from one another, it is not difficult to explain a void in space without resorting to the postulation of supercivilizations.

Steven Novella
New Fairfield, Conn.

The Male Pill

I read the article "Male Pill," by Carol A. Johmann [April 1982], with great interest. However, the article did not delve deeply enough into the research being done on a contraceptive pill for men.

I have been a guinea pig for some of the experiments being conducted by Harbor-UCLA Medical Center.

The hormone they have been working with is a neurohormone called gonatotropic-releasing hormone, which is a ten-amino-acid peptone. This hormone decreases the reproductive functions of the male on two levels: at the level of the pituitary gland and that of the testes.

In irregular doses, the hormone acts like a fertility drug. In regular daily doses, however, the hope of researchers is that it will be an effective contraceptive.

Bob Aldrich
Eureka, Calif.

Population Control

I read *Omni*'s interview with Lionel Tiger [April 1982] and agree with him on many of his points; however, in some areas, he seems to contradict himself. At one point he says, "The population expansion is so rapid . . . that we have too many people living in an environment with too many real pollutants." Later he says that "sterilization equals pill use as a form of contraception. It's a form of suicide—genetic suicide. I truly don't understand it."

Tiger seems to respect only biology. I believe he displayed a real disrespect for, and even a resentment of, our cognitive powers.

Surely it was our ever-present biological selves who brought about overpopulation. And I find it inspiring that we are turning around the horrors of overpopulation by the use of our cognitive powers through voluntary sterilization. Reversing overpopulation is survival, not suicide.

Pamela Montgomery
Rushville, Mo.

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BREAKTHROUGHS

CONTINUED FROM PAGE 38

fall in the form of a video game marketed by Bitlyx, a joint venture formed by Biofuel and a company called Design West. Next year the company plans to roll out a Biovision television set priced between $1,000 and $2,000. At that price, who is going to buy the set, to watch what? "It's a product for videophiles," says Payne. "Sports and pornography should be big three-D hits."

NEW PRODUCTS

A reclining outdoor chair rotates every 15 minutes so indolent sunbathers don't have to do it themselves. The cushioned chaise longue, ensuring an even tan, works only when the sun is out; it gets its power from a photovoltaic panel. A pressure sensor activates the $4,400 chair as soon as someone sits down and clicks it off when the sunbather rises. (Hammacher Schlemmer, 145 East Fifty-seventh Street, New York, NY 10022.)

The future may well be plastics, at least as far as bicycles go. The Itera bike began as a research project to help design a plastic car. From its handlebars to its eight-spoked wheels, from its one-piece frame to its puncture-proof tires, the new bicycle is made from injection-molded, glass-reinforced thermoplastic and other lightweight composite materials. The plastic cycle is available in 1-, 3-, 6-, 10-, and 12-speed models at prices from $250 to $340. (Itera AB, Stora Nygatan 17, S-411 18, Gothenburg, Sweden.)

Japanese inventors appear to have followed a white rabbit down the eighteenth hole with a new device for golfers that ends the need for caddies—and fairways. The Golf Trainer replaces both the golf course and the golf ball with electronic gadgetry. It's a 14" × 21" snippet of synthetic turf with a magnetic sensing device. As the golfer swings the head of the club over the turf, the display indicates which part of the club would have made contact with the imaginary ball, and the direction and distance the ball would have gone. The Golf Trainer, which operates on AC or batteries, folds into a small carrying case. (About $260 from Mitsubishi Electric, 2-2-3 Marunouchi, Chiyoda-ku, Tokyo 100, Japan.)

For many people, the spice of life does not include salt, which can cause hypertension and other serious physical disorders. But simply avoiding salt shakers cannot guarantee a salt-free or even a low-salt diet, since many foods and beverages already contain high levels of sodium. The Original Salt Meter (Life Power Products, 5316 West Imperial Highway, Suite 116, Los Angeles, CA 90210) offers one solution. The counter-top appliance, costing about $100, has a built-in probe to monitor sodium levels. The 2.5-pound unit is portable, although it requires an electric outlet.

NEXT OMNI

MYSTERIES OF THE MIND
issue explores the fascinating ers rginat and
ynithine circuitry of the human brain. "ing In the ani
package. • Nobelist Sir John Eccles on the dil n mind and
neuroscientist Karl Pribram on the mind as w investige
altered states of consciousness, • mind machine ch genes, • b
for depression, • neuron codes • learning withou s and mu

VIDEO WARS—Okay, you've played Pac-Man, Missile Comm and, and p
until your fingers are numb. but now, you're looking for a real challeng
month's *Omni* takes you into the world of video-game designers for a look a
the new wave of contenders will be. Competition is heating up to produ
game that will be not just another shoot-em-up but a test of analytical s
beyond that is what one top designer fantasizes about, the Ultimate

MOBIUS PSI-Q II—Can your mind leave your body to travel through space?
you sit in your living room and accurately describe places or events hundr
miles away? If so, does this special talent hinge upon the contours of you
sanality? These questions will be answered for readers next month, when *Omni*
sents Psi Q II, a new remote-viewing experiment designed by the Mobius G

FICTION—Isaac Asimov's long-awaited sequel to the Foundation trilogy is c
ing *Foundation's Edge* makes its debut in *Omni*, continuing the saga of
Seldon's dream to reconstruct the Empire. Readers may not be familiar with
yard Kipling's science-fiction tales, but "A Matter of Fact" is one of his best
Omni is proud to reintroduce another classic. Prominent author Frederik Pohl
tributes a story that probes society with a sharp wit. "The Farmer on the D

EXPLORATIONS

CONTINUED FROM PAGE 40

employs swift diplomacy to reverse the all-too-familiar destiny of well-trodden paths. In the case of the Galapagos Archipelago he persuaded the Ecuadorian government to preserve the unique flora and fauna so species would continue to serve as examples of Darwin's ideas. On Easter Island, Lindblad and his team set out to revitalize Polynesian culture, raising $280,000 to restore temples, help revive the language and even import a musicologist to renew interest in traditional dances and songs.

Because the *Explorer* travels in little-known waters, many archaeological, anthropological and geological discoveries have been made. Scientific data are recorded in the ship's logs, which are valued by London's Royal Geographical Society and Washington's National Science Foundation. Soundings in uncharted waters are regularly sent to the hydrography department at Greenwich, England, where maps of the world are compiled.

Even after 23 voyages on the *Lindblad Explorer*, Peter Scott attests to the very real sense of discovery inherent onboard. "We like to speak of each cruise as an expedition. Although the itinerary is broadly outlined before we set off, it is sufficiently flexible to visit the unexpected along the way."

Keen to record every bird in the sky and fish in the sea, Scott describes his most recent expedition on the *Explorer*. "From just north of the Antarctic Circle to the Philippines we recorded some three hundred species of coral-reef fish. A few remain unidentified, at least one is almost certainly new to science." Scott was particularly impressed by the "enthusiasm of the most unexpected people for keeping a regular whale watch and recording birds and butterflies."

The greatest enthusiasm, however, was inspired by the discovery of an island—every armchair explorer's dream. "This was a rather small island," Scott writes, "at one end of a long coral reef in the Louisiade Archipelago, southeast of New Guinea. As the island was not marked on the charts we were able to draw it in and give it a name. The house flag was duly planted."

The *Explorer* continues to expand its itinerary. Last year Lindblad guided 8,000 visitors through the People's Republic of China and hopes someday to lead an expedition to see pandas in the wild. "If this can be done safely as far as the pandas are concerned." But despite the growing number of excursions Lindblad offers, the most popular destination remains that "awful place" where once only explorers ventured. ∞

For further information, write Lindblad Travel, 8 Wright Street, Westport, CT 06880; Society Expeditions, 723 Broadway East, Seattle, WA 98102; and Special Expeditions, 133 East Fifty-fifth Street, New York, NY 10022.

PHENOMENA

Miles of a petrified ebony river snake toward the horizon in this dramatic shot of a young lava flow cooled and hardened in midmotion. Photographer Anthony Wolff came across this once-molten landscape during a visit to Santiago Island, in the Galápagos chain, off the coast of South America. Acres of the island were smothered with this volcanic crust, which had congealed into the distinctive swirling formation known in Hawaiian as *pahoehoe*, or rope lava. During his visit Wolff was most impressed by Santiago Island's stunningly bleak and hostile environment. Walking was tremendously difficult because of the sharp, treacherously uneven surface of the volcanic formation. Even standing on it was uncomfortable. Intense heat waves shimmered up from the black stonescape. Wolff recorded this vista on Kodachrome 64 film, using a 28mm lens on his Nikon F camera.

COSMIC TEST TUBES

STARS

By Marcia F. Bartusiak

There are no gleaming test tubes, no whirling centrifuges separating exotic mixtures. Yet it is nature's largest chemical laboratory, our home galaxy, the Milky Way.

Over the past 20 years astronomers have found about 60 kinds of molecules tumbling and colliding in the dusty regions of this galaxy where new stars are being born. As radio telescopes scan the heavens, each molecular species is identified by a certain spectral signature, distinctive radio or infrared waves that the molecule emits after absorbing energy from the surrounding dust cloud.

The discovery of this vast galactic chemistry set came as quite a surprise. For many years it was thought only the simplest molecules could survive the rigors of interstellar space; larger ones would be broken apart even as they formed. But now the ever-growing list of celestial chemicals includes water, ammonia, ethyl alcohol, the welding fuel acetylene, the preservative formaldehyde, and a host of exotic molecules too volatile to exist on Earth.

Most experts agree that the list is far from complete. Some speculate that those tenuous seas of gas are concocting even more complex organic compounds, molecules that are the precursors of life itself. The tentative proof comes from the laboratory glassware of a few researchers in the United States and Europe who right here on Earth are simulating the conditions of an interstellar cloud.

One of these cosmic vessels sits atop a workbench in Thomas Wdowiak's (pronounced Dow-ee-ack) physics laboratory at the University of Alabama at Birmingham. The assembly consists of a tiny vacuum chamber cooled to a frigid space temperature of −441°F and containing a penny-sized sapphire disk that mimics the core of an interstellar dust grain.

Wdowiak's Earth-bound journey into an interstellar cloud begins with a small tube of methane, a basic constituent of interstellar space, and argon gas. Energized with a spark coil, the tube starts to glow like a hot-pink neon sign. Some of the methane molecules ionize (that is, become electrically charged), others break apart, just as they do when struck by ultraviolet rays in space. Millennia of irradiation are compressed into a few hours. These excited molecules race down the tube, enter the vacuum chamber, and strike the cold sapphire disk, forming a thin frost. Some of the molecules react en route, as if colliding in space. Others meet and combine on that pseudo-dust grain.

"Of course, there's no laboratory big enough to simulate an interstellar cloud exactly," Wdowiak notes. "Out in space the molecules are very far from one another. That's why we use the argon. In our experiment we're imprisoning the excited molecules in inert argon ice, so that they can't easily get at one another."

A tungsten lamp shines down on the disk's frosty covering, so that one can observe how the combining molecules absorb and emit light. This spectrum identifies the products. For the first hour of a test, Wdowiak sees *only* simple molecules already detected by radio astronomers. "But later we start to see larger molecules that no one has yet identified in space—molecules composed of long strings of carbon atoms," he says. "Interestingly enough, this star dust smells like synthetic rubber."

Can such laboratory products really be made in space? Quite possibly. When the lamp illuminates the disk, the carbon molecules frozen in that cosmic ice emit three distinct wavelengths of red and yellow light. Wdowiak recently discovered that those same features closely match the spectrum of a glow given off by a cloud of space dust and gas named the Red Rectangle, a nebula located about 1,100 light-years from Earth.

In the future he plans to use his cosmic chamber as a probe to determine what other substances may lie frozen on interstellar grains. The plan: Adjust the composition and proportions of his mixtures to match the as-yet-unidentified spectral signatures coming from space. "You can't create a star in a laboratory," he says, "but you can create the molecules and the dust."

North American Nebula. Mixes of stars, dust, and gas like this are cosmic chemistry sets.

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GAMES

By Scot Morris

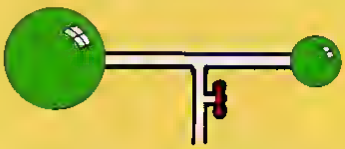
This month's puzzlements deal with physics and common sense. If you suffer from formulaphobia, nothing in what follows should trigger an attack. You won't have to deal with cosines or joules or ergs or volts or vectors. You won't have to let x equal anything.

Christopher P. Jargocki, who teaches physics at Northeastern University in Boston, helped us prepare this quiz. Most of the items are adapted from his *More Scientific Braintwisters and Paradoxes*, to be published this month by Van Nostrand Reinhold Inc. (© 1982 VNR, used with permission).

We start with some down-to-earth questions about sports, we progress to bubbles, buckets, and bridges, then launch into the stratosphere and beyond.

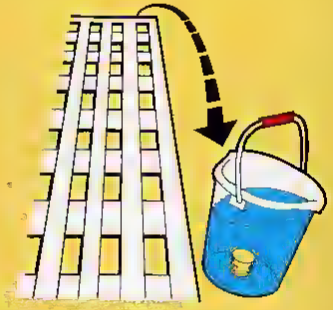
1. FOOTRACE. Mel and Sid race each other in a 100-yard dash. Mel wins by ten yards. They decide to race again, but this time, to make things fairer, Mel begins ten yards behind the starting line. Assuming they both run with the same constant speed as before, who wins this time, Mel or Sid? Or do they tie?

2. JUMPING TO CONCLUSIONS. A high jumper tells you that on his best jump—7'6"—his body passed over the crossbar while his center of gravity passed entirely under it. Is he tunning you? If not, explain how this could happen.



3. BUBBLE BIT. Two soap bubbles, unequal in size, are blown on the ends of a T-shaped tube. The blowing inlet is then closed, leaving an air passage connecting the two bubbles through the tube, as shown. What will happen? Will the smaller bubble expand at the expense of the larger one until they are both the same size? Or will something else happen? Or will nothing happen?

4. CALL OF THE SIREN. The speed of sound in air is about 740 mph. Suppose that a police car is sounding its siren and driving toward you at 60 mph. At what speed is the sound of the siren approaching you?



5. WATCH OUT BELOW. A bucket of water containing a cork held down to its bottom is dropped from the top of a building. The moment the bucket is dropped, the cork is released by some means so that it is free to float in the water. Where is the cork right before the bucket hits the ground?

6. CANNON BATTLE. Two identical cannons are aimed directly at each other, as in the illustration. The only difference is that the cannon on the left is at the top of a cliff and shooting downward, the one on the right is aiming up. Neglecting air resistance, what will happen if the perfectly aligned charges are fired simultaneously and at the same speeds?

7. BIG GUNS. In very long-range artillery the guns are often set at elevation angles ranging from 50° to 70° above the horizontal. This is a much steeper angle than the 45° angle that we are told by elementary mechanics is supposed to guarantee maximum range. Why do artillery gunners seem to violate this simple law of physics?

8. BIG BRIDGES. Imagine two bridges that are exactly alike except that every dimension in one is twice as large as in the other. For example, the large bridge is two times longer, its structural members are two times thicker, and so forth. Which bridge is stronger, or is their strength the same?

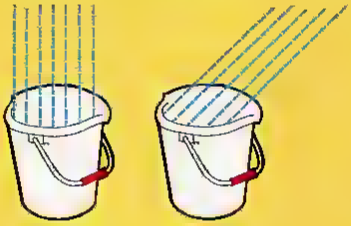
9. BIG BOATS. Imagine two sailboats built to exactly the same proportions except that one is twice as large as the other. Its masts are twice as thick, its sails are twice as long and twice as wide. Even though the sails are made out of the same kind of canvas, if the weight of the sail itself can be ignored, which sailboat will be more likely to have its sails torn by the force of the wind?

10. COLD COMFORT. When an airliner is flying at an altitude of 30,000 feet, the temperature of the air outside may be as low as −30°F. One might think that this would require the use of heaters inside the cabin, but in fact an aircraft flying this high must use air conditioners. Why?

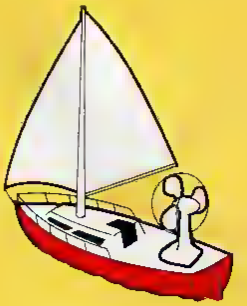
11. FULL BRIGHT. The lighted area of the full moon is about twice as large as that of the moon at first or last quarter. That should mean that the full moon is twice as bright as the quarter crescent, but in fact the full moon is about *nine times* brighter. Why?

12. METEORS IN THE MORNING. On any clear night a shooting star can be seen in the sky about every ten minutes, on the average. It is commonly observed, however, that many more meteors are seen in the early-morning hours, between midnight and sunrise, than are seen in the evening between sunset and midnight. An astronomy student tells you that he

thinks the reason for this is that artificial lights in homes and offices are usually turned off in the wee morning hours, which makes the whole sky more visible. What do you think of the student's reasoning? Can you think of a better explanation for reports of morning meteors? Do Australians observe the same phenomenon, or is the situation reversed "down under"?



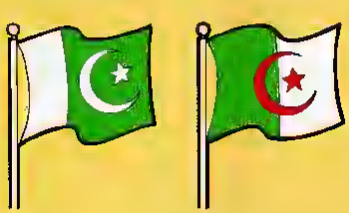
13. BUCKETS OF RAIN. A bucket is sitting out in the rain, as shown above at left. If the wind begins to blow and rain starts falling at an angle, will the bucket fill up faster or slower, or will the rate of filling remain the same? Note that in the windy condition, above at right, the cross-sectional area of rain that falls into the bucket decreases.



14. SAIL AWAY. You wanted to sail your model sailboat today, but there is no wind at all and your boat is in the doldrums. Would it be possible to propel your boat by mounting a battery-operated fan on the rear of the boat and directing the fan to blow wind into the sails?

15. THE MOUNTS OF MARS. If a mountain's size is determined by measuring the height to which it rises from its base, then the tallest mountain on Earth is not Mount Everest, but the Hawaiian volcano Mauna Kea. It rises 31,000 feet above the ocean floor—surpassing Mount Everest by nearly 2,000 feet—but only 13,823 feet of Mauna Kea shows above the ocean surface.

Olympus Mons, the tallest mountain on Mars, is estimated to rise at least 80,000 feet. Mars is only about half the earth's size, yet it has mountains that are more than 2.5 times taller than any that are found on Earth. Any explanation?



16. FLAG FALLACY? Above are the flags of Pakistan (left) and Algeria (right). The flags of the Comoro Islands, Mauritania and Tunisia have similar designs. Astronomically, is there anything "wrong" with them?

17. WHERE AM I? Suppose you are a passenger in a doughnut-shaped space station; it is spinning around its hub to produce a simulated gravity of one g, exactly mimicking the gravity of Earth. You are in a small, windowless room, and so you cannot see the rest of the space station. Inside your room everything seems "normal"—gravity seems to be operating on you exactly as it would on Earth. In fact, as far as your senses can tell you, you *are* on Earth.

In your pocket you have a magnet, a piece of string, some coins, a pencil, and a steel paper clip. Is there a simple test you could do in your room, using one or more of these objects, that would confirm you are on a spinning space station and not on Earth?

18. A LADLE JOKE. What is the mass of a cubic meter of Oriental soup?

Answers begin below.

COMPETITION #25: OMNI DICTIONARY

**Ax: chopstick
**Bering Straits: What the navigator is supposed to get
**Comic section: The part of the newspaper where you find *Peanuts*
**Cube root: Diced carrots
**Denial: Where Cleopatra lived
**Drive-in movie: Wall-to-wall car petting
**The English Channel: Station where you watch *Masterpiece Theatre*

Above, a sampling from the first five letters of *Omni's Fractured Dictionary*. Help us complete letters *A* through *E*. Send us up to three original definitions for words starting with the first five letters of the alphabet. The grand-prize winner will receive $100; runners up (2–10), $25 each. All entries become the property of *Omni* and will not be returned. Postcards are preferred. Send your entries by October 15 to: *Omni* Competition #25, 909 Third Avenue, New York, NY 10022.

ANSWERS

The following are the answers to the physics quiz starting on page 136.

1. RACE. Mel wins again. In the second race, after Sid has gone 90 yards, Mel will have gone 100, and they will be alongside each other. There are 10 more yards to run, and since Mel is the faster runner, he will finish first.

2. JUMP. Yes, in fact when the bar is set at 7'6" there is virtually no other way to do it. A high jumper may be able to raise his center of gravity (CG) up to his own height, but not much more. When a six-foot tall jumper clears a 7'6" bar, his CG remains about 1'6" below the bar. The

CONTINUED ON PAGE 130

LAST WORD

By Frank Kendig

"Has the mathematician become an endangered species like the snail darter or the Chinese moose, or is he perhaps part of some sinister conspiracy?"

A quiz, to start:

1. Name a mathematician alive today.
2. Name a mathematician who lived in the last 300 years. (Einstein doesn't count, he was a lowly physicist.)
3. Name a mathematician who lived anytime, anyplace.

How did you do?

Don't feel bad, it's a hard test.

Everybody should have answered number three. Thales. Plato. Euclid. Archimedes, household names every one. Pythagoras is a popular answer. A lot of people remember Pythagoras. Descartes is another good one. I'll even stretch the rules and accept Isaac Newton and Christiaan Huygens.

Question number two begins to separate the wheat from the chaff. A roster of the best-known mathematicians of the last 300 years would include Karl Gauss, Pierre de Fermat, Wilhelm Leibniz, David Hilbert, Godfrey Hardy, Alfred North Whitehead, Bertrand Russell, Kurt Gödel, and John von Neumann—all good answers. Some of these names are even familiar, but usually not in any mathematical connection. Gauss, for example, is best remembered as a physicist. Russell as husband to five wives. von Neumann as the man who brought us electronic banking.

But question number one is the killer. Did you come up with Hassler Whitney or Rene Thom or Andre Weil or Harish-Chandra or Armand Borel or Enrico Bombieri? Perhaps one of the new Russian topologists, Farkas Bolyai, for example? If you had any answer for number one, you are in a tiny minority. With the exception of mathematicians and physicists (and I'm not sure about the physicists), hardly anyone can name a living mathematician.

This is an intriguing situation. Has the mathematician become an endangered species like the snail darter or the Chinese moose, or is he perhaps part of some sinister conspiracy—low profile, deep cover, secretly circulating among us like the Mafia or the CIA? After all, St. Augustine warned, "The danger already exists that the mathematicians have made a covenant with the devil to darken the spirit and to confine man in the bonds of Hell."

There are, of course, shadowy signs of them here and there. Researchers in almost every area of science have developed a stutter, a semantic tic: "I can't explain the mathematics behind it, but..." *Can't explain*, more often than not, means "don't understand." The implication is that there is someone who *can* explain and *does* understand. Behind most scientists, it seems, is an unsung mathematician. But why unsung? Why don't we see him brandishing a tennis racket in *People* magazine?

Part of the problem is that it is difficult if not impossible to talk to a mathematician about what he does. The conversation quickly slips into seven-dimensional spheres, folding topological envelopes, and the relentless search for a last paired prime.

And it is not simply a matter of catching up. If we could converse with a mathematician of a century ago, the talk would be no less puzzling. Then the popular topics were the calculus of invariants, the arithmetic of infinities, the topology of *n*-dimensional surfaces, and the various geometries in which parallel lines always meet. About the only people who can comprehend the mathematics of a century ago are the mathematicians of today. They are the keepers of the flame, members of an invisible priesthood.

Some mathematicians have been carried away by the grandeur of their art. Bertrand Russell, for example, modestly called it "a practice of supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry."

Comparisons of mathematics with poetry and sculpture, especially in Russell's ultraviolet prose, suggest that perhaps mathematicians are like poets and sculptors and makers of stone axes—nice to have around, but not particularly useful. Mathematicians often encourage this impression. Morris Kline characterizes mathematics as a "great body of knowledge that contains no truths."

Despite claims like this, mathematics continues to make a considerable difference. The Greek geometers, no matter how pure their concern for the essence of form and shape, made possible such mundane skills as navigation, surveying, and architecture. The modern mathematicians, beginning with Gauss, provided a framework for the ongoing revolution in physics.

The members of the invisible priesthood are spinners of intricate webs of logic, out of which they build castles in the air. And occasionally a scientist comes along, pulls one down, and scraps it for parts he needs. John von Neumann described it another way. "It is as if one bought a top hat for a wedding," he said, "and discovered later, when a fire broke out, that it could be used as a water bucket."

Frank Kendig is a free lance writer. He was formerly executive editor of Omni.