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APRIL 1983

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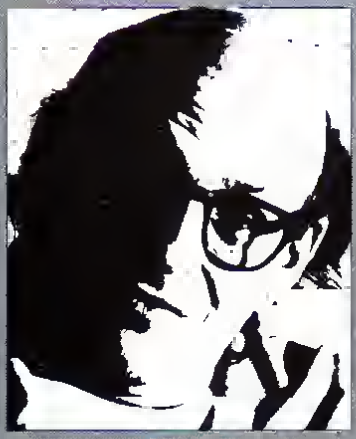
Carl Fiatow, a New York-based photographer, was inspired by Michelangelo's "The Creation of Man" to interpret the re-creation of mechanoids in man's own image. This comment on the emergence of robots in our time was commissioned for World magazine



FIRST WORD

By Marvin Minsky

"What kinds of minds and personalities should we dispense to robots? What kinds of rights and privileges should we withhold from them?"

As the era of the robot approaches *Omni* is devoting much of this issue to the question of how intelligent machines might change our lives. We're rapidly adjusting to using automation in our science, art, and businesses. But so far machines have helped us mainly with the things we hate to do. What then will happen when we face new options in our work and home, where more intelligent machines can better do the things we like to do? What kinds of minds and personalities should we dispense to them? What kinds of rights and privileges should we withhold from them? Are we ready to face such questions?

Today our robots are like toys. They do only the simple things they're programmed to. But clearly they're about to cross the edgeless line past which they'll do the things we are programmed to. Already there's so much power in those arcade chips that one might think the toys are playing with our kids.

Most robots rolling around these days are mere fakes, remote-controlled by people hiding out of view. A few, though, do some things that real robots ought to do, like sensing the sounds of certain words and acting on those words and phrases. And as they reap the fruits of research, these machines will show more visible signs of having minds.

For years there existed an odd paradox. We learned to make computers expert in many special skills but couldn't endow them with much ordinary common sense. Why not? The reason was so simple it was hard to see. We're all so accustomed to using common sense that we take it for granted, but it's actually the most complicated thing we do! An "expert" can get by with a few kinds of highly specialized information, but a sensible person needs a large body of general knowledge. We'll have to wait awhile longer for computer sensibility—a decade or a century, perhaps, but just a moment in the grand march of history.

So, soon enough we'll learn to make computers organize their thoughts. We'll make them learn from us and help teach others, too. We'll give them inhumanly dextrous limbs and uncannily observant senses, and also show them how to build copies of themselves. This could begin a flood of "automatic self-replication"—machines making more machines at very low cost. Then we'll learn to cope with the resulting exponential growth of wealth and productivity.

What will it take to make machines that really think, that solve new problems? It won't suffice just to feed computers a lot of separate facts; each must be linked to other things we know. A mind is merely the web formed by such connections; its quality depends on how well it correlates the scraps of knowledge in that web and when it decides to use those scraps—and when not to. (Common sense, for example, demands knowing the exceptions to the rule: "You can put things in your pocket—but not if they're too big to fit, belong to someone else, or bite too hard." And minds must also know about their own intentions, how and when one should persist, submit, or balance between action and reflection.

How big are they, these human webs of information and belief? I'd guess a billion links would more than match the mind of any sage. A billion seconds stretches 30 years—and no psychologist has ever found a way to make a person learn something new each second for any prolonged period. But a billion bytes of memory may soon be cheap. Today computer memories do single operations at a time; soon they'll do millions simultaneously. But let's face facts. We just don't yet know how to weave our knowledge webs into our new machines. I see this as the most exciting research problem of our time: how to put enough mechanisms together in harmony to form minds of growing competence and breadth. Most people still think such things must be impossible to understand. I think they're only very complicated.

Eventually the day will arrive when human knowledge becomes the domain of the computer. When everything we want is already done for us by thinking machines, how will we then spend our time? Which entertainments will we choose, what custom-programmed mental stimuli? And what of Time itself—how long will we tolerate the meager years our bodies last? Our mortal stay seems fixed by makeshift engineering. Our body cells, "controlled" by programmed suicide and war, degenerate and die as immune systems fail and misinform us to destroy ourselves.

I'm sick of hearing evolution praised. No self-respecting programmer would bury software bugs such dreadful ways! I'd bet we'd do at least as well to start afresh (without that billion-year accumulated mess) and try to transfer all we really want from those vast symbol-process structure webs we call our selves into more safe and neat immortal codes.

Then finally we'll have to think of how to treat minds made to our design. How right will it be to switch them on and off? How wrong would it be not to make all the minds one can? Our present civilization's code of ethics came to us too easily. It assumes that man has no control over mind. We had to choose only how far our loyalty need reach, past family and friend, to stranger from another land. But when we really start to make ourselves, why then we'll really have to face ourselves. ∞

Marvin Minsky is former president of the American Association for Artificial Intelligence.

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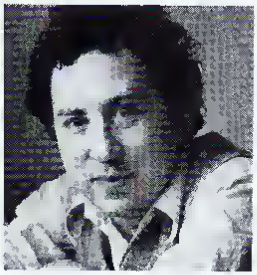

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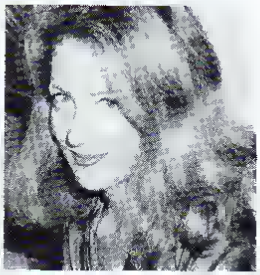

WOODSON

Welcome to the Era of Robotics, the focus of this issue of *Omni*. The pages ahead celebrate the arrival of a technology that promises to alter the next 100 years as surely as the steam engine transformed the century before. But our reports of the coming robotic revolution also carry a counterpoint: The growth of these humanlike machines has stirred substantial misgivings and even some primordial fears.

Consider an obvious and immediate problem: the rapid robotization of industry and the displacement of millions of workers. A labor-and-technology analyst at MIT predicts that in the next ten years, General Motors alone will purchase 20,000 robots that will disrupt the lives of 40,000 to 50,000 auto workers. But according to *Stanley Polcyn* (page 35), unless the United States introduces robots into industry, it won't be able to compete with foreign markets, and even more jobs will be lost. Polcyn is president of the Robot Institute of America and senior vice-president of Unimation, Inc., a leader in the construction of industrial robots.

Many other prominent, respected—and sometimes eccentric—authorities have contributed to this issue. John McCarthy, one of the founding fathers of robotics and the man who coined the phrase *artificial intelligence* (AI), is the subject of this month's Interview (see page 100). And in First Word (page 6) *Marvin Minsky*, another pioneer of superintelligent machines, shares his philosophical musings about the role of mechanoids. Cofounder, with McCarthy, of MIT's AI laboratory, Minsky forecasts a world in which robots will be programmed as we are programmed—that is, their computer brains will be capable of common sense.

At the same time robots stimulate questions about human learning and development, the machines themselves are becoming more like people. On page 26 freelance writer *Michael Edelhart* describes a fledgling science called robo-psychology that studies this phenomenon. In researching his article Edelhart met Rover—the crude prototype of a "smart robot—which can respond intelligently to novel situations and can sense and maneuver around obstacles without preprogrammed instructions.

But as robots gain intelligence, they also provoke more controversy. And in fact, controversy spread even to the *Omni* staff, specifically over the choice of illustration for the story "Robots at Home" (page 70). Art director *Elizabeth Woodson* chose a painting of a female humanoid with mechanical arms for its beauty and for its synthesis of woman and machine. But writer *Richard Wolkomir* points out: "The robots in the article have *male* names, such as Isaac and Bob. Anyway, in my house we divide the so-called woman's work."

Overall editor of our robotics section was senior editor *Douglas Colligan*.

STAFF OF JAPANESE *OMNI*

In addition to celebrating machines of the future, this month we also salute the past and future achievements of the Japanese edition of *Omni*. The Obunsha Company, publishers of a wide assortment of books, educational reference works, and magazines, launched the Japanese version in May 1982. The edition is our second native-language entry into the international market (the first is the Italian *Omni*). It draws 50 percent of its material from the concurrent U.S. edition, with the remaining 50 percent derived from past U.S. editions and independent Japanese sources. Our congratulations go to president Yoshio Akao, executive director Takuji Ishikawa, editor in chief Tadashi Okada, and the entire staff on a successful first year.

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APRIL

LETTERS

COMMUNICATIONS

Cloned Archaeologist

I have studied archaeoastronomy under Anthony F. Aveni at Colgate University located in Hamilton, New York. Some years ago I heard a rumor that Mr. Aveni was cloned while on a field trip in Mesoamerica. He is now supposed to be able to do twice as much work as he could do before.

To get to the point: in your September 1982 issue, Robert Patton's article "Ooparts" mentions an Anthony Avini. This Avini is supposed to be an anthropologist at Cornell University. Since Cornell is not very far from Colgate and both these researchers seem to be working on the same project of mapping Nazcan lines, could this Avini be the long sought-after clone of past rumors? I called Cornell University information and they told me that there is no Anthony Avini teaching or working in the anthropology department. The National Geographic Foundation informed me that there *is* an Anthony Aveni who is doing a study funded by them. He is an astronomy professor at Colgate University.

All this is very confusing. I thought the clone rumor had ended, but now I'm not so sure. With all this detective work, I may need my own clone. Will the real Anthony Aveni please stand up?

John Lam
New Haven, CT

We stand corrected. The real Anthony F. Aveni is, in fact, a professor of astronomy at Colgate University.—Ed

Women in Love

The news that women can be sexually aggressive to the point of savagery ["When Women Rape Men," The Body, December 1982] would have come as no surprise to Euripides, author of *The Bacchae*. As Freud often reminded us, the ancient Greek writers had seen it all.

An attack by a group of women also played an important role in the life of D.H. Lawrence. Employed in a factory where he was one of only a few males, Lawrence was popular with the girls. He was, however, unprepared for the explosive and violent sexuality of the female factory workers. Caught off guard, he was emotionally, if not physically, raped. This experience became the subject of his celebrated short story "Tickets, Please," and, according to a close friend, was the direct cause of Lawrence's well-known cynical attitude toward women.

George Whitesel
Jacksonville, AL

Waiting for Asimov

I truly appreciated the October 1982 anniversary issue. The excerpt from *Foundation's Edge*, Isaac Asimov's latest entry in the field of SF, was especially welcome. Being but fifteen, I read the *Foundation* trilogy only three years ago, so I cannot imagine the anguish of those who have waited closer to three decades for this new book.

Russell Paulsen
Dixon, IL

Space Food

Noel Vietmeyer's pictorial "Seeds of a New Eden" in the December 1982 issue was just great. It's good to know that when NASA is finally ready to build their space station, there will be technology available for food production in space. The Sadiyat Island challenge that was accepted by the University of Arizona crew is a giant step in the right direction—feeding the masses.

Keep up the fine reporting. It's great to see that there are some positive outlooks in this world of ours.

John Starr
Caldwell, ID

Sakharov

I thoroughly enjoyed your article "Genius Hunting" [November 1982], especially the part about the Chudnovsky brothers.

Omni readers might be interested in knowing that Marcel Dekker has just published the *Collected Scientific Works of Andrei D. Sakharov*, edited by David and Gregory Chudnovsky.

Marlene Goldrich
New York

CONTINUED ON PAGE 144

DIALOGUE

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.

$65,000 Mother

It always seems to be a man who laments the lower birth rates ["Baby Makers Inc.," Continuum, September 1982], and his solution is to have the government or a corporation use embryo implantation or artificial insemination to make babies in test tubes.

As a woman let me tell you that getting pregnant (though it can be life-endangering) is the least objection I have to making babies. I also do not mind being pregnant. I actually enjoy it and find it to be a very healthful, happy time.

My contention is that producing babies is not the issue. There should be no problem finding women who would, for a reasonable fee, be happy to spend a year being pregnant. It seems to me that $35,000 would be a reasonable price for this service.

The real problem is finding enough people interested in devoting about 18 years of their time toward socializing, educating, and raising another human being. I haven't seen many men willing to give up nearly two decades of emotional and physical freedom to do that.

If men, or their state, want more babies, let them do the raising, feeding, nurturing, and training. Or let them begin to pay decent wages for such a job. It seems that $65,000 is an excellent place to start negotiating.

Ruth Austen
Riverside, CA

Hardy-Har

Who do you think was amused by the two pages devoted to Art Cumings's cartoon ["The Artist"] in the November 1982 issue? Your female readership?

I was surprised to find this cartoon in your magazine. Since your first issue I have looked to *Omni* as an oasis of intelligence in the sterile desert of the media. Mr. Cumings's "hardy-har" little wifey humor is more fitting for a Sunday supplement than a magazine of your caliber, and I can only wonder if it reflects the sentiments of your editors, as well. Why else would you give two precious pages of full color to this "cute" piece when you could have devoted the space to one of your other excellent features.

I am sure you realize that *Omni* readers are a special group of people: unique, intelligent, and highly perceptive. But perhaps you don't realize that the female readership of your magazine is even more unique—a technologically literate group of women who undoubtedly have better things to do than nag their husbands about taking out the garbage.

Marna Kern
Savannah, GA

Equality In Space

It was with great amusement that I read Kathy Keeton's First Word [December 1982] on women in space. In her naive article she states, "Women's superior reflexes and endurance capabilities will give them the edge as the spaceship drivers of the future. And they may fare better in space itself." She also reports: "The results of a rigorous five-year study by NASA proved women superior to any group of men at adapting to the physical and emotional challenges of space."

At twenty-two, I hold a master's in aeronautical engineering, and a bachelor's in computer science. I'm in superb physical condition and am seriously considering joining NASA to become an astronaut. With all these credentials, I know that there is no female who can even come close to me in any physical or mental test. I don't care how many studies NASA conducts.

Men are superior to women and will fare better in space. This statement may label me as the perfect male chauvinist, but I look at things realistically.

Let's face it: women just don't measure up to men in conditions that demand strength, ruggedness, endurance, speed, and bravery. History has proven this. I would like to bring Kathy Keeton back to reality and prevent her and other women from being disappointed.

Zenith R. D. Knight
Port Washington, NY

As the medical officer in charge of heat-stress evaluation of the Mercury Astronaut Selection Program at Wright-Patterson Air Force Base during the late 1950s, I had the opportunity to become quite familiar with the physiological reactions to heat of astronaut candidates in top physical condition. During the course of the program some women (nonastronaut candidates and physically untrained) were also tested. Their individual results were far superior to those of the male astronauts as a whole: while the women absorbed heat faster from the environment, their physiological reactions were much milder than the men's, perhaps indicating that Kathy Keeton's argument has some basis. Although one cannot generalize on the basis of several individual tests, it is my recollection that these women who underwent heat tests also excelled in altitude, centrifuge, and other stress tests.

Joseph Gold, M.D.
Syracuse, NY

No Women Allowed?

It is distressing to read in a purportedly progressive magazine like *Omni* an article as blatantly sexist as "Tinkering With Ufopia," by Michel Salomon [November 1982]. Is it not the central issue of our times that women should enjoy a more important, decisive role in society than they have in the past? Why does Mr. Salomon find it unnecessary to include the opinions of some of the eminent women in our scientific community? By excluding women from his article, Mr. Salomon has seriously weakened its credibility: he is omitting at least half of the knowledge and opinions available—a serious oversight for a supposedly forward-looking piece of research.

D. G. Anderson
Ottawa, Ont., Canada

THE GREENING OF WEST GERMANY

EARTH

By James Kitfield

When West German authorities began construction of Frankfurt's new airport runway they expected a battle. They were not disappointed. Protesters bitterly opposed to the destruction of a forest in the runway's path raised flaming roadblocks that strangled airport traffic. Nearby in the fashionable downtown shopping district other demonstrators challenged bands of riot police equipped with armored trucks and water cannons. The doomed forest itself which environmentalists had spent years trying to protect was the scene of the worst fighting. In one day alone more than 100 policemen were injured—by angry youths hurling steel balls and by elderly women throwing acorns and pinecones.

Supertanker crews and shipyard workers watched first in curiosity then in disbelief as a ragtag flotilla of fishing boats lined up to block the mouth of Hamburg harbor. For years fishermen had complained of industrial pollutants poisoning the fish in Hamburg's Elbe River and now when the damage seemed irreversible, they gagged the harbor in a last act of defiance. Soon after, the leader of the blockade loaded his family aboard his boat and set sail for Ireland.

In America the sight of knapsack-carrying youths hitchhiking for hundreds of miles might have signaled a huge pop festival. But this was West Germany and these were protesters heading for Bonn to greet President Ronald Reagan. The American President had come in hopes of persuading West German leaders to aim Pershing II missiles at East Germany. To the demonstrators who numbered over 200,000 the problem was one of perception. When Ronald Reagan looked over the wall to the east, he clearly saw the enemy. When young West Germans looked in the same direction they saw a welter of humanity—and the other half of their country.

West German politicians had long believed these protests to be widely disparate events. But to a group meeting in Offenbach's modern City Hall at the end of 1979 the connection between such demonstrations was obvious. Each new protest they declared was one more cry heralding the noisy birth of Germany's new political force the Green Party, dedicated to nuclear disarmament and a clean uncluttered environment.

The roots of the Green Party can be traced to the years following World War II when the Germans were struggling to reconstruct their society. Their factories desperately turned out automobiles and refrigerators machine tools and cameras until by the Sixties Germany became the world's fourth-largest industrial power.

This success however also made Germany one of the most polluted nations on earth. Its affluent population soon choked streets and highways with eight times more automobiles per square mile than could be found in the United States. Frenetic manufacturing plants produced some 450 million cubic yards of refuse yearly—enough to form a mound as high as the Zugspitze the country's tallest peak. And though tons of sulfur dioxide carbon monoxide and hydrocarbons spewed daily from a maze of factory smokestacks, the nation's avid industrialists were constantly clearing land to make way for still bigger manufacturing plants.

By the early Seventies a generation of Germans bred on ecological devastation had come of age. And many of them despised what they saw. As one young woman who took part in the Frankfurt runway protests explains: "In a country like Germany you come to see the futility of your life-style. We began to hate industry consumption, and their poisonous by-products. Our parents' work seemed empty even destructive. They went about their business without considering the damage they caused. That type of attitude was frightening to us. We had to find another way."

That new way soon became apparent. In Ruhr City a hazy wasteland of belching factories and fumes, walls were covered with a single bold slogan: "*Schade das Beton nicht brennt*," or "Too

Pollution in West Germany has spawned a generation of youth dedicated to the environment.

CONTINUED ON PAGE 121

RELIGIOUS GENES

LIFE

By Helen E. Fisher

Beneath the quiet towns of central France, the Pyrenees and northern Spain, restless ancient torrents carved out a labyrinth of caves. Here, in the windless yawning chasms deep below the ground, stalagmites and stalactites stand like ivory soldiers dripping bullets of water that make metallic pings in the utter quiet. The sounds of bats dance off craggy pits and hollows. And the roar of still living rivers rushes up through chutes, funnels and "cat holes," then vanishes into total stillness at some hairpin turn.

What nature built, our ancestors came to decorate between 10,000 and 35,000 years ago, leaving behind thousands of cave paintings and engravings—mementos of their deepest beliefs. In the giant underground rotundas at Lascaux cave, in central France, someone painted dozens of stampeding herd animals. In a recess of Les Trois Freres cave in the Pyrenees, another early artist incised a magical beast—with the head of a man, the antlers of a stag, and the tail of a horse. And in La Juyo cave in Spain ancestral magicians carved a monstrous stone head, half man, half cat.

In over 30 caves in France and Spain giant bison, reindeer, mammoths, ibex, bears, and other beasts are outlined in red or black, their fur and muscles filled in with carefully placed strokes that use the natural protrusions and fissures of the walls themselves. And where real figures give way to magical ones, headless horses, duckbilled people, wolf-headed bears, disembodied hands, floating arms and legs, snake patterns, and dots and dashes are portrayed. Some of these paintings appear in large central areas that could have housed over 100 spectators of—or actual participants in—ancient ceremonies. Others are carved or painted in such inaccessible culs-de-sac that professional spelunkers have fainted from claustrophobia trying to gain access to these remote passages.

In these sunless tunnels, amid heightened sounds and cool, stagnant air, something of significance was going on—or so theorizes anthropologist John Pfeiffer in his new book, *The Creative Explosion*. As Pfeiffer suggests, religious leaders may have reserved the private sanctums for individual ordeals, confrontations, or communions with the spirit world. For larger ceremonies, early masters of trickery and illusion may have led their kin through convoluted alleys, playing flutes, drums, xylophones, and castanets while they held lamps beneath the paintings. The flickering torchlight would have caught one image and suddenly another. Then, after the tortuous trek, these first priests may have assembled their flocks in the grand rotundas, where disoriented audiences, their senses stripped of normal time and place, were held in rapt attention.

But what were the shamans conveying during their cryptic rituals? What did the paintings mean? Why this sudden first flowering of human art and ceremony? Pfeiffer's explanation is bound to ruffle the feathers of both creationists and antisociobiologists, for within his theory lies the suggestion that religious fervor has a biological component.

His controversial hypothesis is based on events that took place some 40,000 years ago, when irrevocable climatic changes were sweeping Europe and Africa. Glaciers to the north and desert to the south concentrated populations in France and Spain. At this time the Neanderthals, ancient racial variants of modern man, died out—replaced by today's human beings. These new individuals, the Cro-Magnons, began to make new tools out of such experimental materials as ivory, bone, and antler. Whereas the Neanderthals used only large stone implements to fell their prey, tan their hides, and pound their seeds and berries, these modern people were much more innovative. They invented bracelets, pendants, and beads to adorn their bodies, and needles to sew man's first tailored clothing. For the hunt they fashioned lightweight harpoons and miniature projectile points, perhaps used in the first bows and arrows.

If so, now hunters could move off the high plateaus to pitch their skin tents at the fords of valley streams and shoot

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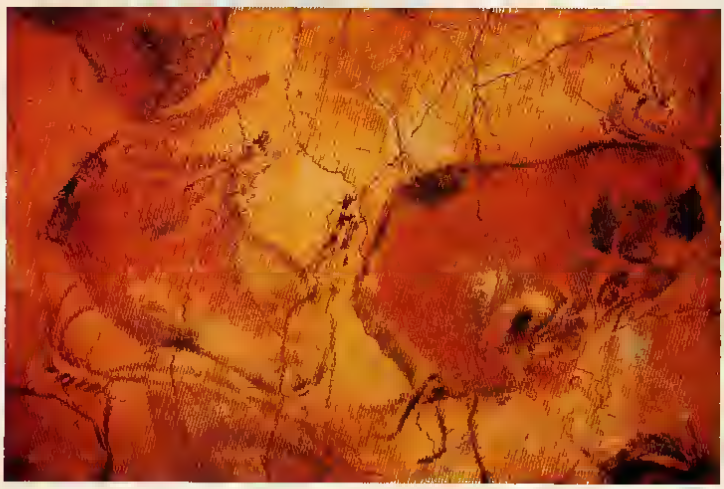

Cave paintings of real and imaginary beasts may be remnants of an ancient survival course

STARSHIP MAKERS

SPACE

By T. A. Heppenheimer

Forget science fiction starships. And forget about the British Interplanetary Society's theoretical papers on interstellar travel. their *Daedalus* starcraft probably won't fly, and if it did would soon explode according to some advanced computer studies in the United States. The most important starship work in the world takes place at the University of California's Lawrence Livermore Laboratory, where the U.S. government has paid people like Roderick Hyde and Lowell Wood to work on the design of starship engines.

To be fair, the Lawrence Livermore ship has a few features in common with the Britishers' *Daedalus*.

- It is powered by microscopic hydrogen bombs, each less than a millimeter across, each detonating with the modest force of a firecracker.
- These microexplosions will be set off by intense laser beams now being developed at the laboratory for weapons simulation and fusion-power research.
- The hot exhaust that drives the rocket will be expelled from a nozzle formed with magnetic fields, not ordinary metal or ceramic. This approach offers performance vastly better than that of any rocket now in existence.

For years, tight security restrictions kept the details of the work by Hyde, Wood, and their colleagues largely unknown outside Lawrence Livermore itself. Recently, news of the starship plans has begun to leak.

The story begins in 1972. Rod Hyde was just completing the requirements for his B.S. at MIT after little more than two years. He was interested in astrodynamics, the science of orbits and trajectories, followed by spacecraft. He wondered whether some advanced, exotic engine might not indeed turn interplanetary flight paths into straight lines.

At the same time, Lowell Wood was one of Livermore's brash young leaders in the new field of laser fusion. His work called for preparing micropellets of fusion fuel, then zapping them with powerful laser beams to produce tiny hydrogen-bomb explosions. In addition, he was a recruiter for a fellowship program, this job took him to MIT, where he and Hyde talked of future engines.

Both scientists agreed that laser microexplosions might be used to propel a starship. Wood arranged for Hyde to get the fellowship and visit Livermore for the summer. Without a security clearance, Hyde couldn't work on the real problems, which involved classified questions about the pellets and lasers. But he could study other details, including Wood's notion of using magnetic fields to form a rocket exhaust nozzle. These fields would allow exploding pellets to blow out the craft's back and produce thrust. Such a rocket could achieve performance a thousand times better than anything yet flown.

Hyde's work—most of it packed into four straight days and nights of calculating and writing so that he could finish in time to attend the world chess championship in Iceland—yielded an amazingly detailed approach to the starship design. He presented his report to the world of aerospace engineering at the Propulsion Specialist Conference in New Orleans, late in 1972. Hyde laid it all out—the physics, the design concepts, the calculations, and the performance equations.

Almost no one in the audience had the background to follow him. But soon hundreds of requests for copies of his paper started to pour in. Even the National Security Council, under Henry Kissinger, and the office of the President's science adviser at the White House asked for copies. Hyde was nineteen years old.

Back at Livermore, security became even tighter. Laser fusion and its applications represented a highly classified area of work, and Wood and Hyde were forbidden to publish any more in this area. Hyde wrote a very lengthy report giving many more details. This report, UCRL-16556, has been updated since with new material. Quite likely it is the world's most authoritative reference on starship-engine design. It has never been published, but enough is known to give a fairly clear picture of the current state of the Wood-Hyde starship plans.

The most important part of the secret

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Microscopic hydrogen-bomb explosions, set off by laser beams, will power future starships.

ROBO-PSYCHOLOGY

MIND

By Michael Edelhart

Carefully Rover moves forward. He spots an obstacle in his path and stops to examine it. friend or foe? Satisfied it holds no danger for him, he continues on his way.

An ordinary occurrence, certainly, nothing worth noting, except for the fact that Rover is not a dog, but a robot, an autonomous, moving, environment-evaluating machine created by robot-expert Hans Moravec of Carnegie-Mellon University, in Pittsburgh. What makes Rover so special is his ability to judge the state of the world around him and, in a sense, consider his best interests.

As variables in Rover's environment shift, Moravec notes, "The robot's behavior would change from boldly pursuing its main goal (whatever that may be) to cautiously feeling its way around. We are tempted to give such variables names like 'fear' and 'enthusiasm.'"

What Rover presages is the day when a robot will come equipped with its own psychology. Such a machine would adhere to Isaac Asimov's three laws of robotics, which essentially instruct a robot to protect itself but never at the cost of a human life. And while machines like Rover are not all that sophisticated, they have forced scientists to address the question of what to put in the souls of these new machines.

Already robots in industrial settings all over the world are practicing the prime law of never harming humans. Advanced industrial robots, powerful enough to crush a man by accident, are now equipped with arrays of sensors backed by computer programs that are designed to recognize human forms and motions. If these patterns appear in the work-place, the robot will stop automatically. It "knows" that human safety is more important than any work it must do.

Slightly more complex applications of robo-psychology are being built into experimental mobile robots (see "Robo-Shock!," page 44) like Rover. These robots must be able to sense situations and respond appropriately to circumstances that their programmers might never have anticipated. For example, at Tsukuba University in Japan, robot scientist Yutaka Kanayama's mobile robot Yamabico uses some of these skills.

Early models of Yamabico could avoid obstacles and hazards only if the robot had been specifically programmed to respond to them beforehand. It could not apply its programming to unforeseen situations. If placed on a table, for example, it would simply roll off the edge if not instructed to do otherwise.

The new Yamabico will have more complex software that allows the machine to react to obstacles as it meets them. Special balance sensors and a vision system enable it to look ahead, see an obstacle, or sense an impending edge so that it can react in time. In other words, the robot has an innate sense of self-preservation. The next step, says Kanayama, is to teach Yamabico to recognize common everyday objects and have an understanding of their uses. "Once we give him the ability to sense his universe and then to function in it independently," the scientist says of his machine, "we can start to teach him ways of responding to it."

At the Tokyo Institute of Engineering, Professor Shigeo Hirose has already crafted a robot with responsive abilities. His creation is a four-legged, spiderlike machine (see "Robots: Fantasy Versus Reality," page 80) that can climb stairs of any size without special instructions. A human says "go" and the robot manages the rest itself.

The machine begins its climb down by feeling along the stair's edge using the tactile sensors in its pods, the way a blind man uses his cane. These guide the legs down the back side of the stair, while balance sensors in the squat robot body keep it level horizontally. When a stair is too deep for a leg to touch bottom, the robot lowers its body to give the leg more reach. If the leg still can't reach the next step, the robot stops. It won't allow itself to tip over. It protects itself by responding in a flexible fashion to its environment—psychology at work.

Professor Hirose points out that this is not a state of mind within the machine so much as a way of acting that we

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What kinds of behavior are we to program into the intelligent machines of the future?

ARTIFICIAL INTELLIGENCE

By Phoebe Hoban

By this time next year, your personal computer may be able to store roughly five times more data—even if you own last year's model. The key to squeezing so much extra mileage out of today's machines is a new generation of "vertically recorded" disks.

In laboratories from Tokyo to San Jose to Minneapolis, computer engineers are racing to perfect a promising spinoff of conventional "horizontal" recording technology that could multiply the storage capacity of software by a factor of ten. "This technology could give home-computer users the storage capacity of an IBM mainframe, at a cost per bit cheaper than today's software," claims Jack Taranto, president of Applied Information Memories, in Milpitas, California, which has developed a prototype system.

As even children seem to know in these dazzling days of computer literacy, it is the software that tells a computer how to function and serves as an electronic filing system—automatically storing and retrieving information. The software contains the complex computer instructions (or programs) and the characters of stored data in the form of "bits," the binary one/zero digital code that is the basis of all computer language.

With the exception of those personal computers small enough to fit in a briefcase, most home machines use programs recorded on 5.25-inch floppy disks—thin Mylar platters a little smaller than 45-rpm records. With today's technology, a disk holds a maximum of roughly 850 kilobytes (850,000 characters) of information and sells for about $4. It is read by a disk drive—the computer equivalent of a tape deck.

Like ordinary audio tapes, computer disks are coated with a film of magnetic material—typically iron oxide. Information is recorded and read on the disk by using an electromagnetic head to magnetize the particles so that different regions have different polarities—each acting like a miniature permanent magnet that represents either a one or a zero in the binary code.

In today's horizontal (or longitudinal) recording technique, these microscopic magnets are lined up end to end, like a long row of straight pins. The trick to increasing data storage, however, is to pack the digital bits as closely as possible. The horizontal format inherently limits the bit density, because when the north and the south poles of a magnet are located too close together, they tend to neutralize, causing the material storing the data to demagnetize.

But imagine if you turned these straight pins on end, perpendicular rather than flat in relation to the surface of the disk. Many more pins could be packed much closer together, while the magnetic poles, located on either end of the magnet's length, would remain the same distance apart no matter how tightly the magnets are squeezed side by side.

It sounds like an obvious solution to a geometric puzzle. And, in fact, IBM first started investigating the possibility of vertical recording as early as the 1950s. "Vertical recording is almost as old as recording itself," says Chris Bajorek, manager of IBM's Storage Systems and Technology Research Division, in San Jose, which is working on vertical technology. "The problem was finding the optimal medium."

Close-up shows disk's columnar structure

The breakthrough came in the mid-1970s, when Shunichi Iwasaki, of Japan's Tohoku University, found that a chromium/cobalt mixture provided the perfect columnar structure for vertical recording. "It has a lovely crystal—each one is like a bunch of little pencils," says Clark Johnson, president of Vertimag Systems Corporation, in Minneapolis. Johnson's company has developed a working prototype of a 5.25-inch floppy disk that holds 5 megabytes. The company's pilot plant will begin producing the chromium/cobalt vertical disks, drives, and recording heads early next year.

Other companies have taken slightly different approaches using the same recording principle. Toshiba Corporation of Tokyo, for instance, has demonstrated the prototype of a 3.5-inch floppy disk and drive system that holds 3 megabytes. And at least a dozen more computer manufacturers, including giants like Sperry Univac, Burroughs, Honeywell, Hewlett Packard, Control Data, Nippon Telegraph and Telephone, Olivetti, and Apple, are also working on vertically recorded disks. Products are expected to reach the market within the next 12 to 24 months.

Exactly what does all this technical jargon mean to the consumer? Experts say that a vertically recorded disk could eventually contain 10 to 40 times as much information as today's disks hold. While the vertical disks are expected to sell for $15 to $25, the actual cost per bit will be dramatically cheaper, so the consumer will get much more storage for his money.

Vertimag's Johnson foresees recording mailing lists, encyclopedias, even entire libraries on single disks. And the smaller 3.5-inch disks would be a handy way to upgrade today's briefcase computers. Vertical recording could also have a significant impact on digital audio and

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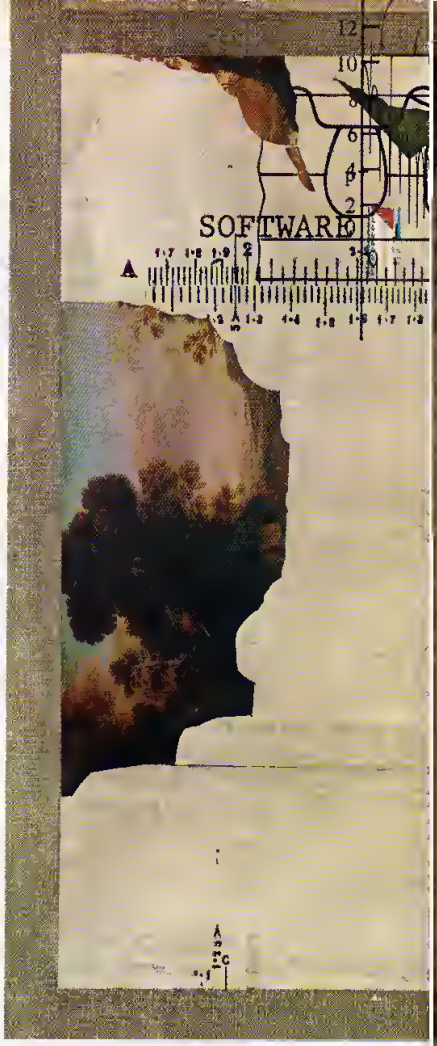
What do IBM people think about?



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CONTINUUM

ROBOTS AND OUR JOBS

For the knee-jerk technophobes among us robots must seem an easy target Each robot on an assembly line replaces, on average two people leaving a single human overseer for every four or five machines Although the need for productivity improvements in manufacturing is generally accepted many members of the press academia labor groups, and corporate management itself link productivity gains—particularly those attributed to robots—with declining employment levels

Yet when we look at the real causes of unemployment in America it becomes clear that in the long run robots will create jobs, not destroy them Consider a few facts

- The steel and auto industries have already lost hundreds of thousands of jobs—far more than the current level of automation can account for
- Even the highest estimates agree that annual robot sales will reach only $2 billion in the early 1990s, or 40 000 machines per year—and that is still ten years away This is certainly a modestly slow rate by most measurements
- Every new advanced technology developed has created employment Witness the computer and semiconductor industries that were nonexistent not long ago
- While unemployment spread here Japan s 1982 trade surplus with the United States totaled some $12 billion equivalent to 480 000 jobs lost by the Americans to the Japanese

Japan a world leader in robot use could achieve that surplus because their goods—particularly in the auto and electronics industries—are sold cheaper and are perceived by many to be better than ours Unless we can change this further loss of jobs is inevitable But if we regain our repulation for quality goods at low prices an expanding job market is just as sure

Automation can help in this effort but not single purpose machines that churn out identical products in enormous volume A recent Pentagon study found that the vast majority of items purchased, even by the military, are made in lots of fewer than 100 What we need are machines that can turn out a few specialized items then be reprogrammed cheaply and accurately to make a slightly different model or another product altogether We need robots to revive our markets and create new jobs

Robots have long had the brawn for machine loading spot welding spray painting die casting materials handling, and other brute force tasks As technology improves robots will acquire control and senses to match These developments will be fueled by our need for greater efficiency to save lagging industries that robots have not yet entered

Robot vision is already well on its way Soon robots will be used say to grade the quality of bacon by comparing the amount of dark meat and white fat Later 3 D vision will let robots recognize one part lying on others in a bin of many components Thus they will learn to assemble intricate machinery without having to be presented parts with special care Already they can assemble a few small electrical relays accurately and fast

The sense of touch will be cheaper and perhaps more usefut It will enable robots to check the parts they handle making sure that each is free of defects Auto-engine valves will no longer be about the right size they will be exact Quality will rise as a result Tomorrow s robots will also be able to handle items too delicate for today's models A decade from now they may shear sheep pick fruit and package easily bruised foods

Where most robots use grippers designed for a single job soon they will carry the most versatile holding device of all—a hand Making it standard equipment will cut the cost of robots so that small businesses will be able to automate their production lines and compete with large manufacturers

The result will be high-quality products and new demand for American goods and services And as our industries recover job opportunities will reappear These new jobs may not be the same ones we have today Assembly-line jobs will be replaced by positions in quality control robot repair, programming and service industries yet to be invented This is no hardship it is a rare factory worker who really enjoys tightening the same bolt in the same car door for years on end

The issue is not whether robots and other technologies should take over American industry It is how to encourage the new businesses they bring and how to train those with obsolete trades to find roles in growth fields desperate for skilled workers

—STANLEY POLCYN

Stanley Polcyn is senior vice president of Unimation Inc and president of the Robot Institute of America an association of robot manufacturers

CONTINUUM

GENDER TRANSPLANT

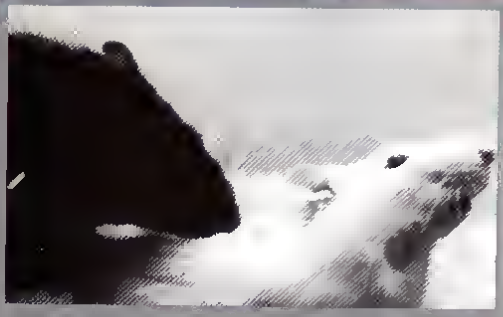
Tiny pieces of living brain were recently transplanted from newborn male rats into newborn females. The result: The females grew up believing themselves to be males, despite their anatomy.

The object of the study, according to neuroscientists Gary Arendash and Roger Gorski of the University of California at Los Angeles, was to determine whether part of the brain could survive and function when transferred from one animal to another.

The dramatic behavior change in the female rats (which now pursue other females in a frenzy) has convinced Arendash and Gorski that brain tissue can indeed survive such transfer. This conclusion is bolstered, they add, by autopsies showing that nerve cells from the transplanted tissue had hooked up to the host brain.

Other researchers have shown that transplanted brain tissue would connect with blood vessels and remain alive, but Arendash says he and Gorski are among the first to show that the neurons themselves would interconnect and the transplanted brain part would function.

The research holds out the promise of a cure for a variety of debilitating human diseases, including Parkinson's disease, multiple sclerosis, Alzheimer's disease, and others, all of which are caused by the loss of neurons in the brain.



Gorski's rats: After the females received transplanted male brain tissue, they began to exhibit male sexual behavior.

If partial brain transplants can be made to work in humans, it should be possible to replace the lost neurons and thus eliminate the disease. —Paul Raeburn

"You cannot hold a man down without staying down with him."

—Booker T. Washington

NOT TONIGHT, TEDDY

If you want your newborn to reach his or her full potential, put away that teddy bear, paint the nursery black and white, and talk baby talk. That, at least, is the advice of Susan Ludington, director of the Infant Stimulation Education Association.

Ludington and other members of the Los Angeles-based organization have spent the past ten years observing infants in hospitals and labs across the country. Now, after synthesizing much of the research, Ludington has come up with a few unusual guidelines.

Although that pink pastel nursery filled with flowers and fluffy stuffed animals may please the parents, she says, a newborn is completely indifferent to such surroundings. During the first six months of life, babies actually prefer sharp, high contrast color combinations, especially black and white. They stare with great concentration at moving dots, stripes, and bold geometric patterns. And says Ludington, "above all, babies love eyes."

Moreover, she notes, the traditional teddy bear can overwhelm a newborn, who would rather play with a mobile composed of three dimensional geometric shapes. Kicking and reaching for the mobile greatly improve a baby's motor skills. The teddy should come months later, to help foster emotional attachments.

To stimulate the right and left hemispheres of the brain, Ludington and her colleagues suggest three Bs: Bach, Brahms, and baby talk. Infants are captivated by the high pitch and regular beat found in all three.

In fact, auditory stimulation can start even in the womb. At the UCLA School of Nursing, where Ludington conducts her research, expectant mothers place earphones against their abdomens and play tapes of "Mommy and Daddy talking." Babies stimulated this way prenatally have eagerly turned their heads in the direction of their parents' voices right after birth. As for music during pregnancy, Ludington recommends Vivaldi's baroque masterpiece *The Four Seasons*.

—Marcia Bartusiak

"I am only a public entertainer who has understood his time."

—Pablo Picasso

Grrrrrr! A teddy bear can overwhelm a newborn baby.

HEART-ATTACK JOBS

Do you work in a highly structured, fast-paced environment? Do you lack the opportunity to make independent on-the-job decisions? If so, you are a likely candidate for cardiovascular disease and heart attack, according to research conducted at Columbia University, in New York City

To reach these conclusions sociologist Robert Karasek examined health and occupational records of men in the United States and Sweden His finding Occupation can be as significant a factor in provoking cardiovascular disease as smoking or blood-cholesterol buildup

Among those at highest risk, Karasek contends, are assembly-line workers and phone-company customer-service representatives People in such occupations experience harmful psychological strain, he notes because they don't have the freedom to ease tension by establishing their own work pace or job technique The service representative, for instance, is the target of nerve-racking abuse from complaining customers, continuous psychological pressure upsets the worker's hormonal balance which may eventually trigger a heart attack

'The myth is that managers run the highest risk of heart disease but they really don't," Karasek says "That is because managers have optimal control over their jobs '

Karasek recommends that management solicit worker suggestions on how to reduce on-the-job psychological strain He also believes that a worker s schedule should be coordinated with his biorhythm chart —Eric Mishara

Illegal still seized by police during Prohibition The backyard still may soon be enlisted in the effort to whip the energy shortage

Assembly line Workers in fast-paced environments with little freedom in decision making run the greatest risk of heart attack

"We expect rough treatment from our colleagues whenever we produce something shoddy . The essential factor which keeps the scientific enterprise healthy is a shared respect for quality '

—Freeman Dyson

MOONSHINE GASOLINE

Don't throw out granddad's old copper still Chemists at Purdue's Laboratory of Renewable Resources Engineering say you might soon be able to use it to home-brew gasoline from grain alcohol

Ethanol, or grain alcohol—the kicker of moonshine whiskey—is not a good fuel Chemically speaking burning a fuel adds oxygen to it, it's that process that releases energy But ethanol already contains oxygen in effect, it has already been partially burned

Removing the oxygen from alcohol is a process Mobil Oil investigated several years ago Chemists there used a synthetic mineral called zeolite to remove the oxygen from methanol—wood alcohol But when the researchers tried the same process with ethanol the reaction emitted so much heat that it destroyed the zeolite

Now Purdue's Martin Chang, Allen Anderson and George Tsao have found a way to slow the process to safe speeds—by adding water By distilling fermented corn or other grains they can produce the right mixture of water and ethanol Just pass the hot vapor from the still into a zeolite-filled chamber at about 400°C, and gasoline comes out the other end Ethanol is still too expensive to compete with petroleum-based gasoline Chang notes but dozens of scientists are working to reduce the cost —Robert L Forward

CONTINUUM

Golden Gate The or dge of choice for tne graceful dead

A SUICIDE OF QUALITY

A desire to go out with a sense of grace may be one reason many suicides choose to leap off the Golden Gate Bridge instead of the nearby San Fran cisco–Oakland Bay Bridge Thaf s fhe conclusion of University of California at Berkeley suicide specialist Richard Seiden, who has found that five times as many people jump from the famed Golden Gate

The Gofden Gate Bridge joins San Francisco and the counties of norfhern California and the Bay Bridge connects San Francisco with the cities of the East Bay Yet according to Seiden the romanticized appeal of the Golden Gate Bridge is so strong thaf half the suicides from the East Bay actually *cross* the Bay Bridge to reach the more famous landmark In contrast not a single person from north of the city has jumped from the Bay Bridge in almost 50 years

A big part of the problem s accessibility Seiden says "The Golden Gate Bridge is open to pedestrian traffic The Bay Bridge isn t " Yet when the pedestrian fraffic is eliminated from the analysis the Golden Gate sfill has three times as many suicides

The "power of sugges tion ' Seiden contends is in large part responsible for fhe Golden Gate's allure Tourist agencies for in stance are constantly glorifying the suicide statisfics of the bridge turning it into a kind of suicide shrine---a place where people can end their lives with a sense of beauty '

' Suicide from the Golden Gate has become romanti cized as aesthetically pleasing,' Seiden concludes while jumping from the Bay Bridge is considered 'tacky and declassé ' '

—Marc McCutcheon

' Truth comes out of error more readily than out of confusion

—Francis Bacon

GIT ALONG, LI'L WATER BUFFALO

Imported with great difficulty from Trinidad and Guam by an American rancher with big ideas some 150 water buffalo are now thriving on land in Louisiana Florida Texas, and Missouri These "magnificent beasts " as one researcher describes them, can work like horses, yield good red meat to rival the Angus and Hereford in taste, and produce milk wifh more butterfat and nonfat solids than cow s milk

The first thing most Americans fhink of when they hear water buffalo is a mean vicious creature running and roaring through Africa notes Tony Leonards, of Lake Charles Louisiana who is the only commercial breeder of water buffaloes in the United States No one thinks about a beautiful animal with a show ribbon on him Leonards is working to make that vision a reality

Leonards became a water buffalo enthusiast affer a United Nations report documenfed how well the animals fare under adverse conditions in hot climates providing meat milk and work in exchange for forage too coarse and poor for cattle to eat To take advantage of that endurance, he imporfed some water buffaloes for development and selective breeding hoping to create 'outstanding animals ' for herds in the Unifed Sfafes and throughouf fhe world

'Water buffaloes are not going to replace cattle in the United States, con cedes Wyland Cripe of fhe College of Veterinary Medicine af the University of Florida who is performing basic research in hematology nutrition and reproduction on Leonards s herds 'But they can *supplement* cattle particularly on marginal, swampy land "

Cripe is trying to transfer embryos among water buffaloes and between water buffaloes and cattle If the experiments are successful embryos from either animal might one day be exporfed

Magnificent beast Works like a horse yields good red meat to rival the Angus and Hereford in taste and even produces milk

to undergo birth in another country Since embryos do not normally carry hoof-and-mouth disease their use would eliminate the hassle of quarantine now complicating the importation procedure —Dava Sobel

'The reasonable man adapts himself to the world, the unreasonable one persists in trying to adapt the world to himself Therefore, all progress depends on the unreasonable man '

—George Bernard Shaw

POOR MAN'S COKE

Synthetically manufactured anesthetics with names like Toots Ultracaine and Florida Snow packaged so they seem almost indistinguishable from cocaine, are being sold openly in head shops across the country To kids, these products are low-cost substitutes for real coke Unfortunately they can be fatal

To date the Food and Drug Administration has investigated three deaths it suspects are linked to the use of these commercially available drugs All the victims succumbed to cardiorespiratory arrest after exposure to a combination of three local anesthetics—lidocaine procaine and tetracaine

Pharmacologist Marian W Fischman who has been comparing the effects of cocaine and anesthetics on human subjects at the University of Chicago notes that, although the products aren t stimulants they do 'cause the person to feel high or mildly euphoric " Since the anesthetics are often used to activate nerves that stimulate the heart Fischman adds anyone using these products runs the risk of bringing about undesired changes

According to experts head-shop coke is, understandably far less expensive than the real thing While pure cocaine might sell for $2,000 an ounce an ounce of material laced with lidocaine or procaine sells for as little as $140

—Pablo Fenjves

Teen age snorting The quest for an inexpensive substitute for cocaine can lead to death via cardiorespiratory arrest

"If Jesus Christ were to come today people would not even crucify him They would ask him to dinner and hear what he had to say, and make fun of it '

—Thomas Carlyle

PRODIGY BURNOUT

He was a young violinist on his way to a brilliant career Then one day he quit—put down his violin and never picked it up again He s a high achiever in medical school now but he nurses a sense of failure that may haunt him for life

What stopped him from becoming a Perlman or Paganini? A midlife crisis at age fifteen something that can affect prodigies in music science or the arts says Massachusetts Institute of Technology researcher Jeanne Bamberger

Bamberger, a pianist herself says gifted children uniformly seem to go through a period in their teens when the music that once came so naturally no longer seems to flow The problem occurs because the way children learn is different from the way adults do Like children with less developed talents, the child prodigy learns much of his music intuitively But as he enters adulthood he must relearn his skills fitting them into the more structured, analytic style that typifies adult thought Many successful musicians say they have weathered this change But some children quit and never play again

The learning process of the prodigy is largely unstudied

How prodigies learn is largely unstudied scientists are reluctant to interfere with the delicate process that makes genius So Bamberger is proceeding slowly—first getting to know gifted children and then testing them on computers and musical bells to see how they organize notes She's also helped organize a network of behavioral scientists who will hold two conferences this year on how gifted children learn The results may explain why some prodigies fail so painfully

—Douglas Starr

CONTINUUM

POLYESTER DIET

The shortcomings of a diet become apparent at breakfast when the morning allotment of dry unbuttered toast is served As the day painfully progresses visions of frosted milk shakes and scrumptious cookies sap willpower By midnight, the craven dieter surrenders to temptation and dashes for the kitchen

Wouldn t it be terrific if someone discovered a way to take the calories out of fattening foods? Now an indigestible substitute for culinary fat and oil called sucrose polyester just about does this ' If allows you to ingest what seems to be a conventional high-fat high-cholesterol American diet ' says University of Cincinnati internist Charles Glueck, but it lacks most of the calories because the body s digestive enzymes just can't break it down "

More than 400 of Glueck's patients have already dieted on foods made with sucrose polyester a synthetic compound composed of sucrose and eight fatty acids In one recent trial ten obese volunteers lost an average of eight pounds in 20 days

The calorie-free food substitute blends into a tasty 155-calorie shake with ice milk (270 calories less than the real thing), says Glueck and can be baked in cookies that have 30 calories less than normal Although it lowers vitamin A and E levels in the body, that deficiency can be compensated for with vitamin supplements The compound is currently undergoing Food and Drug Administration review, and, Glueck suggests, it may eventually be sold as a prescription product in the form of a food dressing or spread.

—Eric Mishara

' The brute curiosity of an angel's stare
Turns you like them to stone "
—Allen Tate

"There is precious little in civilization to appeal to a yeti "
—Sir Edmund Hillary

The heartbreak of a diet breakfast Now a substitute for fat and oil made from sucrose polyester can make dieting livable

Better-fed children were more expressive less anxious more readily involved in group activities and more open to new situations

UNDERNOURISHED EMOTIONS

Emotional health may depend upon how well an individual eats during the first years of life, according to psychologist David Barrett of the Children's Hospital Medical Center in Boston

Barrett reached this conclusion after studying 138 Guatemalan youngsters Some of the children had received a high-calorie protein and carbohydrate nutritional supplement from birth while others just received a low-calorie supplement without the protein To see how nutrition affected development Barrett tested both groups at age six and found behavioral differences between them

'The better-supplemented children were more expressive" Barrett said 'They were less anxious more readily involved in group activities, and more willing to pursue a frustrating task or explore a new situation such as playing with strange toys "

Other researchers had assessed the home situation of each child the size and condition of the house the availability of warm clothing and the amount of teaching provided by the mother These elements turned out to be reliable predictors of intelligence-test performance, Barrett said but generally did not influence social and emotional behavior The findings suggest that intellectual and emotional development may be affected by different physiological and environmental influences

Coinvestigators in the study were Marian Radke Yarrow of the National Institute of Mental Health, and Robert E Klein, of the Institute of Nutrition of Central America and Panama —Dava Sobel

Men like Howard Hughes have inspired the myth that it helps to be neurotic to get rich. Now, it appears the myth may be true

RICH NEUROTICS

Neurotics may have the inside track on making money after all.

Men with neurotic symptoms ranging from anxiety and mild depression to occasional fits of panic earn more than men diagnosed as mentally fit, according to a new study linking psychiatric condition to earning capacity.

The study also found that neurotics were generally higher in native intelligence, better educated, and more likely to be employed full time than men untouched by neurosis.

To conduct the study, economist Lee Benham and mathematician Alexandra Benham, both from Washington University in St. Louis, traced the psychological and financial profiles of 434 elementary-school children diagnosed at mental clinics in the late 1920s right through to adulthood some 30 years later. Of the 434 white males reviewed, 25 percent were regarded as mentally healthy, 56 percent as neurotic, 19 percent as sociopathic, and 10 percent as psychotic. The neurotics, researchers learned, earned 23 percent more than those considered totally healthy.

If neurotics really do earn more, does neurosis cause the higher income, or vice versa? Lee Benham theorizes that compulsive behaviors such as extreme attention to detail often develop into successful business tools. "My best guess," he notes, "is that the disorder causes the income differential."

He adds, however, "We're not recommending that people go nuts to get rich."—Robert Brody

"The civilization of one epoch becomes the manure of the next."

—Cyril Connolly

FOAM HOME

A new kind of house, made of the same material as disposable coffee cups, could provide a strong, energy-efficient shelter from the cold, even for residents of the northern United States. In fact, one such house has proved far more energy efficient than conventionally built homes, and just as fire-resistant and strong.

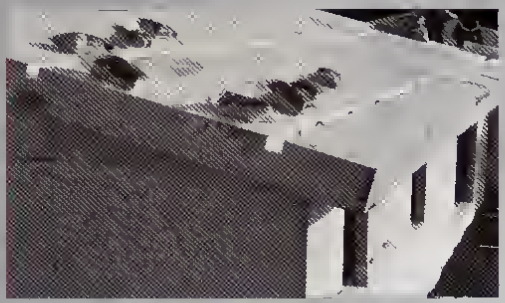
Designed by Wisconsin entrepreneur Don Peterson, the house resembles a standard adobe home, but consists of foot-thick blocks of expanded polystyrene, also used to make Styrofoam. The walls are coated with an acrylic, fire-resistant cement, then anchored to the foundation with reinforcing iron bars.

All this makes the structure so energy-tight that, theoretically, it could be warmed with human body heat, says Peterson. One house near Madison, where temperatures routinely drop below 0°F in the winter, is expected to have a heating bill of $100, versus the nearly $800 that the owners of a comparably sized conventional dwelling would pay. Peterson tested the strength of another foam home he built by hoisting a Mack truck onto the roof; later he ignited all the furniture inside. Firemen who entered the structure after the blaze detected neither structural damage nor toxic fumes emanating from the walls.

The home comes in nearly two dozen models, ranging from cottage-sized to a roomy, four-bedroom split-level. The cost, about the same as a comparable brick or wood home. Provisionally approved in Wisconsin, the design is awaiting federal building-code approval, which may come this spring. After that, says Peterson, you'll be able to buy kits with all the foam blocks you need, color and number-coded for assembly.—Douglas Starr

"The moon is the mother of pathos and pity."

—Wallace Stevens



Polystyrene house. Fire resistant, strong enough to hold a Mack truck, and so energy-tight it could be warmed by body heat.

CONTINUUM

A psychologist has discovered that children of schizophrenics display a weak brain-wave pulse in response to changes in pitch

PREDICTING SCHIZOPHRENIA

The child of a schizophrenic has a good chance of becoming schizophrenic too. If psychologists could just identify the most vulnerable offspring, they might be able to treat them early and head off the disorder.

Now researchers may be on the verge of doing just that, according to psychologist David Friedman of the New York State Psychiatric Institute.

To see whether he could weed out potential schizophrenics, Friedman played a steady series of tones for normal children and the children of schizophrenic parents. Occasionally he'd interrupt the tone or alter its pitch. The children were asked to signal every time they detected a change.

Friedman and his colleagues L. Erlenmeyer-Kimling and Barbara Cornblatt measured a surge of brain-wave activity whenever the children heard a change in the tones. But the brain wave pulse was much weaker in the children of schizophrenics than in the normal children. The researchers also found weakened brain-wave response in adult schizophrenics.

The findings are puzzling, but Friedman thinks they might reflect the inability of schizophrenics—and potential schizophrenics—to respond properly to changes in their social and physical environment.

Friedman would like to refine his tests to the point where he can predict with certainty which children will become schizophrenic without treatment. He suspects that it might be impossible to do this by studying brain waves alone, though, because schizophrenia is such a complex malady. And even if he does learn to predict schizophrenia, he will still face an even more vexing problem: what to do to prevent it. —Paul Raeburn

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"Universities are of course hostile to geniuses."
—Ralph Waldo Emerson

ELECTROCUTED CELLS

When living cells are electrocuted, they spin, burst, stick together, or open and close according to the frequency of the current passed through them. West German scientists led by Ulrich Zimmerman, at the Institute for Chemistry in Julich just west of Cologne, have perfected electrocution techniques so exquisitely that they can choreograph plant or animal cells into a balletic dance.

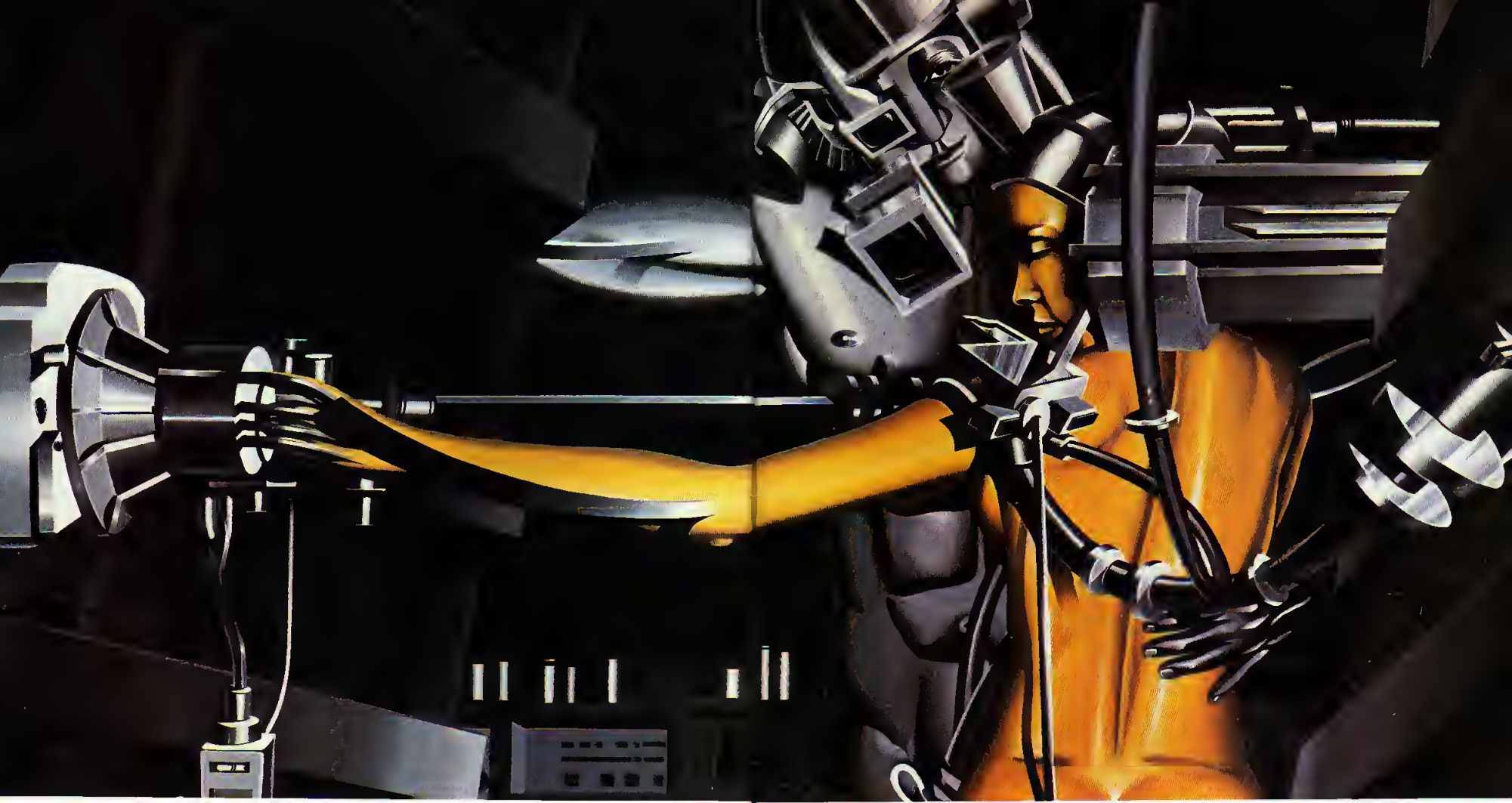
At one frequency, for example, the cells line up between the electrodes like a pearl necklace. At another frequency, the necklace of cells merges, thereby forming a grotesque "supercell" hybrid.

According to Zimmerman, the ability to fuse different kinds of cells with electricity may be crucial to genetic engineers who want to create hybrid organisms containing the characteristics of several species.

Electricity may also be used to split red blood cells for a second, just long enough for drugs to be popped inside without letting the contents of the cell spew out. When the researchers used this method to inject drugs into mice, they found that the drug-laden blood cells traveled through the bloodstream normally. When the abnormal cells reached the liver or spleen, they were attacked, as expected, and the drugs poured out.

And the possibilities do not end there. If electrocuted cells are kept alive longer, enzymes or hormones could be wrapped up and released into the body bit by bit over several weeks or months. Such a technique might help scientists obliterate the ravages of diabetes or hemophilia caused by the absence of necessary enzymes.
—Paul Simons

Electrocuted cells line up like a pearl necklace



ROBO-SHOCK!

BY KATHLEEN STEIN

Fledgling machines trigger old fears

PAINTING BY FRANCISCO MELO

Melinda and Kirk and Mike and Mark are making a robot. They call it R202, the name of the building they work in at a company called TRW. "R202's purpose in life will be to move around the office and look at things," says Michael Jamgochian, one of its four systems-engineer creators, "to explore . . . to go from Mark Thomsen's desk to Melinda Sherbring's desk when we tell it to and to avoid obstacles and people." Eventually "it will enter, deliver one-liners, and leave," adds Kirk Moody.

Although the TRW group is trying to keep the design simple and modular, building an adaptive, autonomous robot is an ambitious project—perhaps never really done before—fraught with major problems on every level. The biggest hurdle facing the TRW quartet, however, is not technological. It's financial. Employed by TRW, one of the biggest high-tech companies in the United States, the robot's makers aren't getting a nickel from the firm for research and development. R202's gestation and birth must take place after the working day. Melinda, Kirk, Mike and Mark have a bright idea, and they have to moonlight it.

In a sense, robotics can be seen as a symbol of American technology today, a bellwether indicating the direction of industry, employment, electronic intelligence, and the human use of human beings. And in a sense, the boxlike, rolling R202 is a symbol of robotics. Its creators, like hopeful parents, want it to win friends, move freely in high circles, and learn steadily. But R202 faces growing pains. Although TRW is supplying some hardware, R202 hasn't yet been given the dowry of corporate support it needs to enter the American workforce. Some people in fact are blatantly terrified of such machines.

Robots make news. The silly slave creatures in the movies generate a huge new toy industry, while the giant praying mantis-type assembly-line robot steadily displaces blue-collar workers in the midlands. When Isaac Asimov recently quipped, "Robots don't kill people, robots kill jobs," he was only half right. In 1982 the Japanese disclosed information they'd been hiding. A robot had fatally crushed a worker who had strayed into its personal zone. The Japanese supposedly welcome each new robot with a Shinto ceremony when it is installed. Yet behind the scenes Japanese labor unions are beginning to express deep concern about the security of their rank and file.

"Four million Americans out of a job by 1990," blares one forecast. And according to Harley Shaiken, labor and technology analyst at the Massachusetts Institute of Technology, in the next ten years General Motors alone will purchase 20,000 robots. These machines could displace another 40,000 to 50,000 auto workers besides the thousands already laid off directly and indirectly by automation.

"The argument is often raised," Shaiken says, "that unless we introduce robots, industries in the United States will not be able to compete, and even more jobs will be lost. But that's half an argument. It doesn't tell us who will lose their jobs. For workers, robots or foreign competition is merely a choice between hanging and the electric chair. And that's the bind we, as a society, have to break out of."

Others argue that the loss of jobs is not the most difficult economic challenge posed by robots. "Retraining is the major social problem created by rapid robotization," says industrial-robot expert Eli Lustgarten of Paine Webber Mitchell Hutchins, Inc., "not unemployment. Massive retraining programs will be needed to prevent the creation of an oversupply of workers whose skills have become obsolete." And at the moment very little is being done to create retraining programs, much less to draw up strategies such as shorter work hours or longer-range plans for the robotized economy as a whole.

"Robots have an extraordinary potential to be beneficial," Shaiken continues. "Robotics is a technology that could enhance the quality of life. But the technology will not do that automatically. If robots are used without regard for how humans are affected, then their promise will be perverted. To talk about their promise in the abstract tells us very little."

> *"For workers, robots or foreign competition is merely a choice between hanging and the electric chair. And we, as a society, will have to break out of that bind."*

Could robots determine Ronald Reagan's future? Shaiken thinks so. Robots will be an issue in the 1984 presidential elections, he says, popping up in debates about employment, job security, and the future of American technology.

Robots trigger some odd anxieties. Look at the letters to the Mego Corporation, in New York, which makes a robotlike toy called the Mego 2-XL. "I apologize for nearly denying my son the opportunity to befriend a 2-XL because of my prejudice," one letter says. Another: "I'm sure Wayne would rather have a 2-XL help him with his homework than me." Or: "Our friends play with 2-XL more than with us." Is this the pattern of the future—robots replacing parents, friends, and teachers in people's affections? When homebots are a ubiquitous presence in the social fabric, will they be treated to the whole emotional gamut—love, hate, paranoia, lust—that humans inflict on one another? Probably. And what will it do to us? That remains to be seen. But Tom McLaughlin, an actor renowned for his robot roles (he taught Woody Allen's robot-actors in *Sleeper*), tells us he thinks humans might get a little bored and fatigued with being surrounded by inorganic zombies that are relentlessly precise, logical, and tireless—even in their mistakes—never acting on a hunch, intuition, or impulse of fantasy.

New York psychologist Diane Connors thinks there could be a problem if robots take over too many human endeavors. "Experiencing errors and then fixing them is part of the creative process," she says. "Error sometimes becomes purposefully embedded in objects, and that's often what gives them their richness."

And of course, there are the more primordial fears. "Some people believe devils could come to dwell in robots," and control them and us," McLaughlin says. Another expert cites apprehension over "robo-terrorism," a scenario in which a mad electrician seizes a centralized computerized control system and marshals all the mechanical rovers into squadrons of killer troops guided by a central processor. And then there's the time-honored *Sorcerer's Apprentice* theme, echoed by the Isley Brothers' "I-turned-you-on-and-now-I-can't-turn-you-off" concept.

But more pervasive today is a kind of mixed anxiety, fear mediated by vague, quasimystical longings for a corporeal machine/man union such as portrayed in *The Demon Seed*. In this grade-B movie Julie Christie is trapped in her own home by her scientist-husband's intelligent computer. The computer builds itself a robot which proceeds to rape and impregnate her. Eventually she gives birth to a golden-scaled, metallic baby-thing.

Robo-shock is here today—both for those whose lives are dominated by the intricacies of actually designing the things, and for those in whose imaginations sleek little mechanoids already serve, obey, and mix the drinks. Actor McLaughlin notes that when he plays a bot, even a robot dandy in a velvet suit, "people come up to me and ask me if I'm real. Real *what*?" McLaughlin laughs. "They think such robots are already here, and they want to know if I'm impersonating one, or *am* one."

When will shock be surpassed by reality? Not for a decade at least, say most experts, and artificial-intelligence (AI) leaders such as John McCarthy (see this month's Interview) think it will take a conceptual leap beyond our wildest theories to accomplish the creation of truly intelligent machines—devices smart enough to challenge their makers.

"There is this immense contrast between some people's notion of what will happen and the harsh realities of what is actually here now," explains David Grossman, manager of automation research at IBM's Thomas J. Watson Research Center

in Yorktown Heights, New York. "When you're in the area of speculative mobile robots—*androids*—you have left the field of what might go wrong and have entered areas where nothing has gone right yet. Indeed, AI and robotics types don't hide the fact that today most robots' vision is dim. They can hardly hear and barely use a natural language. They don't have the dexterity of a six-month old baby."

It is much easier to get a so-called expert system computer to play psychiatrist or diagnose a physical ailment than it is to get a robot to solve the most trivial problem—one that a dog might find simple. Like severely retarded children, who require continuous attention from their parents, today's most advanced robots are doted on second to second by their creators. "In a robot the interaction with the real world is very difficult," says Michael Brady, senior research scientist at MIT's Robotics Laboratory. "You can't form artificial models of the real world with all its warts, wrinkles and bumps. Still, that's what we're trying to do," he says, laughing.

Thomsen of TRW talks about realism backlash. "First everyone had the SF idea that a robot could do anything. Then the industrial-automation people came out saying that's a pipe dream and began cutting back expectations. Right now we're swimming against that. We are at the stage where we can start working on a couple of those pipe dreams."

Marvin Minsky, of MIT's AI lab, has said that robot makers should be designing the flimsiest of automatons—robots that shake, rattle, shudder, experience gear backlash, and droop. And then, he says, we should create sophisticated software to compensate for all the mechanical faults.

The TRW quartet is doing something like that. They will be able—through high-level software and fairly simple hardware—to demonstrate exactly what can be done with the remote sensing rover today. They are in the vanguard. But where is that?

For one thing, even at the forefront of robot research, most machines don't walk. Plans for R202 call for it to roll through an office on three sets of wheels, navigating on its own, past clutter and moving people, at record-breaking speeds of up to one foot per second.

This activity, simple enough for the office goter—or even a centipede—presents the challenge of a dragon hunt for a robot. The most complex problem facing the creators of R202 is designing a program that will continuously update the information the robot receives on its daily rounds and make predictions based on that constant flow of sensory data. The program will give the machine, among other things, an internal representation of the robot's immediate environment. Without this "internal world" in its memory, the machine couldn't move an inch. "It has to be adaptive," Moody says. Sherbrino adds, "Up to now humans would make decisions about where the machine would go. We're trying to give it the capability to make these value judgments by itself."

What will be the robot's biggest problem? People coming up and staring at it. Its designers are quick to say. "It's going to be surrounded by people all the time. It's programmed not to move when it's close to people, so it won't"—a self-protective strategy. The robot is dimly aware of people having been programmed by its makers to "notice" anything that moves and appears vaguely human-sized.

"Imagine yourself," says Jamgochian, "as a robot. All you can do is find out distance measurements with your little ultrasonic sensor. You know how far you've gone in a certain direction, but you're moving on roller skates, so you don't know where you're going. Your eyes are closed.

"Imagine you have to go down a hallway from room A to room B. People are coming up to you and jabbing you and saying, 'Hey, you're going the wrong way.' Or, 'You're starting to get false readings.' We have to put ourselves in the robot's shoes."

> *"I think we're fighting an uphill battle in trying to make computers control robot limbs. Scientists could find ways of making biological machines to do the same thing."*

Right now the TRW group is integrating the software and hardware and encountering many additional subtle and complex problems. "If the wheels spin on an uneven surface, like a carpet, or the joints between rooms, and the program tells the robot to navigate a straight line, it'll have a problem," Thomsen says. "What the robot thinks is a straight line might be something else. The robot will have to correct for that first by measuring with its sensors the distance from walls. Then it will have to keep track of how far it has deviated from its intended path. You have to be certain everything within the robot's internal programming and hardware is precise, because there will be plenty of external deviations and quirks."

"Here's another problem for you," Moody adds. "Say the robot is to move down the hallway in a straight line, but its orientation is off by half a degree. That doesn't sound like much, does it? But move one hundred feet and see how much half a degree causes your robot to deviate."

R202 will be equipped with three types of sensors, the long-distance one being a set of Polaroid sonic range finders, similar to the ones on the camera. Mounted on the robot, the sensors bounce sound off things to determine their distance from the rover. "A major problem here," explains Thomsen, "is that flat surfaces produce ricochets and confusing signals, which sometimes don't indicate a true distance to the robot." Also, says Sherbrino, "if you expect to perceive a wall five feet away, and the sensors suddenly tell you there's nothing in front for fifty feet, what does the robot do? Do you believe your 'internal world' or your sensors?"

The other two sensors are "curb feelers," which order the robot to stop immediately if they touch anything, and "encoders" on the wheel shafts, which measure the angular distance traveled by the wheels. This figure can be translated into distance moved in a direction. "That's how R202 can figure out how far it's gone," Thomsen says. "Then it double-checks against what its internal map says should be around it, and either updates the map or updates the position, depending on where the error is." If there is an error in the integration of these three sense data systems, R202 might go spinning away into a deaf, dumb, sightless void of disorientation, or at least bump into somebody's desk.

While the TRW group struggles with these problems of mobile robots, scientists at the MIT Robotics Laboratory are confronting the challenges of the disembodied robotic arms, hands, fingers, and eyes. Scientists at the lab contend with problems crucial to robot development—accuracy, speed, and gripper tactility, among others. Michael Brady, who claims his is the biggest robotic-research enclave in the United States, with about 30 researchers, told us about the current limits of mechanoid limbs.

The standard industrial-robot arm moves about one meter a second, he says, which is only about the speed of an average person reaching from the stove to the refrigerator while cooking dinner at a leisurely pace. The MIT group is working hard to break this speed limit.

"When I say *fast*," Brady says about MIT's arm, "I mean on the order of five meters a second"—faster than a short-order cook. MIT's arm also accelerates and decelerates with great bursts of speed. "That's where all the arm's effort is expended," he explains. "We're developing an arm with about three-g acceleration... an arm that can deliver something on the order of fifteen pounds at these speeds and torques. So it wouldn't be a good idea to put your head in the way of this robot."

Velocity alone isn't enough. "You don't just want the arm to move at a hell of a speed," Brady continues.

"I mean, if you're reaching like crazy to pluck a glass of wine from a tray before someone else snatches it, you want to make sure you don't whack all the other glasses off the tray while you're at it."

An even greater challenge is mimicking the vast range of motions that is child's

play for human hands. 'The human hand has not one, but twenty-two degrees of motion," Brady says. "It's not powered by one motor, but by forty-eight. Can we build a machine that has such dexterity?

"You've only got to look at the structure of the hand tendon to realize how remarkably complex it is," he continues. "Suppose you construct a multifingered robotic hand. You've got to control the individual tendons, a bunch of tendons acting together to control a single finger, and a bunch of fingers working together to control an entire hand!"

What kind of program would you need to have a robot play something simple like "Chopsticks"? "I wouldn't say as *simple* as 'Chopsticks,'" he responds. "I'd be quite happy if we could get a hand to twirl a baton or roll a ball around in its fingers or be able to figure out how to pick up a Coke can as opposed to a tennis ball. That's the level we're hoping to achieve in the next couple of years."

Most contemporary robots are numb. They grope for parts, and if they don't grasp them they happily flap their grippers around in the air anyway. As Brady says, there's no point in having a hand if you don't put tactile sensors on it.

"There is little experience in building good tactile sensing materials," he says. "The technology is preliminary and the information it yields is fairly coarse—garbage. Current tactile sensors give you only a limited number of points per square centimeter. Or if they give you lots of points, you can't distinguish the characteristics of one material being sensed from another."

Machine vision is Brady's specialty and it's an area that has seen some of the most intensive research in the course of a decade. Still, there have been no solid results. Right now industrial-robot optics are so primitive a machine couldn't tell whether a humble kitchen fork was lying prong side up or down. And that's a simple problem.

The key to making robots more flexible is to provide them with some understanding of, say, where to put down the coffee cup. Brady continues: "Not on the edge of the table, not in the soup. We don't want to have to say every time, 'Move the jar to position X equals twenty-seven, Y equals thirty-two, Z equals something else.' We want the robot to know teapots have spouts and cups have handles."

Removing the scales from a robot's eyes requires extraordinary vision from its creator. If the programmer makes a mistake and the robot's model for "wrenches" isn't complete enough, it will view bad wrenches as good and discard the good one. "If you don't present it with enough information," Brady explains, "it won't understand the concept of wrench."

Paradoxically, designers must store data about emptiness as well as the hard surfaces of things. For a robot to move a teapot through space and not whack either the wine decanter or your mother-in-law, it has to come fortified with extraordinary amounts of data on the space occupied by that particular teapot and on the swept volume as the robot moves through space. To build such a comprehensive data bank, the robot designer must analyze reality on its most primitive geometric level.

"How do I represent free space?" Brady asks. "The space not occupied by things—this particular object that is not an object at all, but is actually full of air? I have to represent that free space and also represent the movement of that much more rarefied object—namely, the robot—through it." Ultimately the designer has to consider every contingency one could encounter anywhere, anytime in the given space and then integrate the reasoning, the vision and the movements into one machine. There is a model for such a device. "It's called a human being," Brady says gleefully.

From *Frankenstein* to *The Stepford Wives*, people seem to want to create artificial versions of themselves—to play God. But today complex android-mechanoid creatures exist only in books and movies wherein they tend to exhibit the rankest forms of egotism and idiosyncrasy. It is as if the mechanical-man concept gives a novelist *carte blanche* to twist human traits to new and bizarre configurations. The crab-shaped robot in *Gravity's Rainbow* makes only a cameo appearance. But in that time the boorish machine continuously smacks gum made of a malleable variation on polyvinyl chloride that sends out detachable molecules transmitting a "damn fair imitation of Beeman's licorice flavor, to the robot's crab brain," writes Thomas Pynchon. In the autocities of Philip K. Dick's *Game Players of Titan*, homeostatic maintenance vehicles collect trash and check lawn growth. Twenty-legged mechanical repair vehicles propel themselves through the streets "hot on the scent of decay."

Today, only in our fantasies do we play out robot soap operas in which the entire household is held hostage when the android maid and the Naugahyde butler mutiny and decide to run the house their way. How can we have a mechanical *Upstairs/Downstairs* when there is nary a robot able to negotiate a single step?

A robot that does all the work in the house is at least twenty years off, according to Kevin Dowling, a researcher at Carnegie-Mellon University in Pittsburgh. "The home, figuratively speaking, is a very dirty environment. Objects are complexly arranged and constantly being changed." But an even bigger problem, Dowling says, will be to find enough work to keep the home robot busy. "Since a domestic robot will be expensive, having it lying around idle would not be cost-effective. You'd probably give it every conceivable task, but if you were gone the whole day the machine would finish in about two hours. And of course there are some complicated legal implications. What if the bot baby-sitter throws the baby out the window? (For a contrasting view

"You're in charge!"

on the future of homebots see "Robots at Home" on page 70.)

There's an alternative to having a house-cleaning machine, offers IBM's David Grossman. "It's called 'design for automation.' Instead of having a robot smart enough to run around vacuuming up your wallet with the dust and throwing the baby out with the garbage, build your house so that it looks like McDonald's, where all the tables are attached to the wall and have only one leg, and the chairs are attached to the table. Then it's easy to mop. Maybe you'd have high-pressure hoses along one side of the wall. Everybody out of the room, turn on the hoses, and all the dirt is sprayed automatically to the other side, where it collects and runs off."

The mention of McDonald's reminds Grossman of an incident related to him by a former robotics colleague. A conglomerate we'll call Ramjac Inc. was considering a completely roboticized version of a fast-food restaurant. Customers could order burgers, shakes, fries, fried shrimp and so on by punching a set of buttons. With each order received, refrigerator doors would swing open deep in the bowels of the earth, and robot arms would grab hamburgers, throw them onto skillets and grab and move milk shakes. Ramjac built a prototype of this culinary wizardry on Long Island, and Grossman's colleague paid a visit to watch it work.

Everything was indeed roboticized except for the final step—putting the food in the bags. That was—and still is—beyond the capability of robots. So at the end of the process stood a human being—with food chutes aimed at him from all directions, and a giant display board that told him what combinations to put in each bag. Everything went well for a couple of minutes. Then he dropped a chocolate shake. He still needed that chocolate, but the next three milk shakes in the shake line were vanilla. He reached around them to get at a chocolate, and in doing so knocked some french fries on the floor.

"Within an hour," concluded Grossman, "he was knee-deep in garbage."

The robot-human connection also went awry at a major New York bank. In learning to love their robo-mailcarts, employees at Citicorp in New York City, were forced to make major psychological adjustments. Previously, human mailpeople had made one-and-a-half-hour pickup circuits. The robo carts made the round trip in ten minutes. According to computer expert Randolph Long, a former Citicorp employee, the carts conditioned the people to set up "internal clocks" in their minds. After about nine and a half minutes," he remembers, "you began to steel yourself for it—the incessant warning beeps and the heavy rattling." The human carriers were a great source of interoffice news and gossip, too, and were sorely missed for that reason. The robo-carts followed tracks sprayed on the carpet, and Long remembers he frequently considered getting a can of the

CONTINUED ON PAGE 90

FICTION

A man could lose his heart in Paris if he can't play the game

BLIND SHEMMY

BY JACK DANN

After covering the burning and sacking of the Via Roma in Naples Carl Pfeiffer a famous newsfax reporter could not resist his compulsion to gamble. He telephoned Joan Otur one of his few friends and insisted that she accompany him to Paris Organ-gambling was legal in France

They dropped from the sky in a transparent Plasticine egg and Paris opened up below them Paris and the glittering chip of diamond that was the Casino Bellecour Except for the dymaxion dome of the Right Bank Joan would not have been able to distinguish Paris from the suburbs beyond A city had grown over the city The grid of the ever-expanding slung city had its own constellations of light and hid Haussmann s ruler-straight boulevards the ancient architectural wonders, even the black, sour-stenched Seine which was an hourglass curve dividing the old city

Their transpod settled to the ground like a dirty snowflake and split silently open letting in the chill night air with its acrid smells of mudflats and cinders and clogged drains Joan and Pfeiffer hurried across the transpad toward the high oaken doors of the casino All around them stretched the bleak,

PAINTING BY ARMODIO

brick-and-concrete wastelands of the city's ruined districts, the fetid warrens on the dome's peripheries which were inhabited by skinheads and Screamers who existed outside the tightly controlled structure of Uptown life. Now, as Pfeiffer touched his hand to a palm-plate sensor, the door opened and admitted them into the casino itself. The precarious outside world was closed out and left behind.

A young man, who reminded Joan of an upright (if possible) Bedlington terrier, led them through the courtyard. He spoke with a clipped English accent and had tufts of woolly bluish-white hair implanted all over his head, face, and body. Only his hands and genitals were hairless.

"He *has* to be working off an indenture," Pfeiffer said sharply as he repressed a sexual urge.

"Shush," Joan said, as the boy gave Pfeiffer a brief, contemptuous look—in Parisian culture you were paying only for the service, not for the smile.

They were led into a simple, but formal, entry lounge, which was crowded, but not uncomfortable. The floor was marbled, a few pornographic icons were discreetly situated around the carefully laid-out comfort niches. The room reminded Joan of a chapel with arcades, figures, and stone courts. Above was a dome, from which radiated a reddish, suffusing light, lending the room an expansiveness of height rather than breadth.

But it was mostly holographic illusion.

They were directed to wait a moment and then presented to the purser, an overweight, balding man who sat behind a small desk. He was dressed in a blue camise shirt and matching caftan, which was buttoned across his wide chest and closed with a red scarf. He was obviously, and uncomfortably, dressed in the colors of the establishment.

"And good evening, Monsieur Pfeiffer and Mademoiselle Otur. We are honored to have such an important guest, or guests, I should say." The purser slipped two cards into a small console. "Your identification cards will be returned to you when you leave." After a pause he asked, "Ah, does Monsieur Pfeiffer wish the lady to be credited on his card?" The purser lowered his eyes, indicating embarrassment. Quite simply, Joan did not have enough credit to be received into the more sophisticated games.

"Yes, of course," Pfeiffer said absently. He felt guilty and anxious about feeling a thrill of desire for that grotesque boy.

"Well, then," said the purser, folding his hands on the desk, "we are at your disposal for as long as you wish to stay with us." He gestured toward the terrier and said, "Johnny will give you the tour," but Pfeiffer politely declined. Johnny ushered them into a central room, which was anything but quiet, and—after a wink at Pfeiffer—discreetly disappeared.

The room was as crowded as the city's ways. It was filled with what looked to be the ragtag, the bums and the street people the captains of the ways. Here was a perfect replica of a street casino, but perfectly safe. This was a street casino, at least to Pfeiffer, who was swept up in the noise and bustle, as he whetted his appetite for the dangerous pleasures of the top level.

Ancient iron bandits whispered "chinka chinka" and rolled their picture-frame eyes in promise of a jackpot, which was immediately transferred to the winner's account by magnetic sleight of hand. The amplified, high-pitched voices of pinball computers on the walls called out winning hands of poker and blackjack. A simulated stabbing drew nothing more than a few glances. Tombstone booths were filled with figures working through their own Stations of the Cross. Hooked-in winners were rewarded with bursts of electrically induced ecstasy; losers writhed in pain and suffered through the brain-crushing aftershock of week-long migraines.

And, of course, battered robots clattered around with the traditional complement of drugs, drink, and food. The only incongruity was a perfectly dressed geisha who quickly disappeared into one of the iris-doors on the far wall.

"The amplified, high-pitched voices of pinball computers on the walls called out winning hands of blackjack. A simulated stabbing drew no more than a few glances."

"Do you want to play the one-armed bandits?" Joan asked, fighting her growing claustrophobia, wishing only to escape into quiet, but she was determined to try to keep Pfeiffer from going upstairs. Yet, ironically—all her emotions seemed to be simultaneously yin and yang—she also wanted him to gamble away his organs. She knew that she would feel a guilty thrill if he lost his heart. Then she pulled down the lever of the one-armed bandit; it would read her finger- and odor-prints and transfer or deduct the proper amount to or from Pfeiffer's account. The eyes rolled and clicked and one hundred international credit dollars was lost. "Easy come, easy go. At least this is a safe way to go. But you didn't come here to be safe, right?" Joan asked mockingly.

"You can remain down here if you like," Pfeiffer said, looking about the room for an exit, noticing that iris doors were spaced every few meters on the nearest wall to his left. *The casino must take up the whole bloody block,* he thought. "How the hell do I get out of here?"

Before Joan could respond, Johnny appeared, as if out of nowhere, and said, "Monsieur Pfeiffer may take any one of the ascenseurs, or if he would care for the view of our palace, he could take the staircase to heaven." He smiled, baring even teeth and curtsied to Pfeiffer, who was blushing. The boy certainly knows his man, Joan thought sourly.

Am I jealous? she asked herself. She cared for Pfeiffer, but didn't *love* him—at least she didn't think she did.

"Shall I attend you?" Johnny asked Pfeiffer, ignoring Joan.

"No," said Pfeiffer. "Now please leave us alone."

"Well, which is it?" asked Joan. "The elevafor would be quickest, zoom you right to the organ room."

"We can take the stairs," Pfeiffer said, a touch of blush still in his cheeks. But he would say nothing about the furry boy. "Jesus, it seems that every time I blink my eye, the stairway disappears."

"I'll show you the way," Joan said, taking his arm.

"Just what I need," Pfeiffer said, smiling, eliminating one small barrier between them.

"I think your rush is over, isn't it? You don't really want to gamble out your guts."

"I came to do something, and I'll follow it through."

The stairwell was empty and, like an object conceived in Alice's Wonderland, it appeared to disappear behind them.

"Cheap tricks," Pfeiffer said.

"Why are you so intent on this?" Joan asked. "If you lose, which you most probably will, you'll never have a day's peace. They can call in your heart, or liver, or—"

"I can buy out, if that should happen," Pfeiffer reddened, but it had nothing to do with his conversation with Joan, to which he was hardly paying attention; he was still thinking about the furry boy.

"You wouldn't gamble them if you thought you could buy out. That's bunk."

"Then I'd get artificials."

"You'd be taking another chance, with the quotas—thanks to your right-wing friends in power."

Pfeiffer didn't take the bait. "I admit defeat," he said. Again he thought of the furry boy's naked, hairless genitals. And with that came the thought of death.

The next level was less crowded and more subdued. There were few electronic games to be seen on the floor. A man passed, dressed in medical white, which indicated that deformation games were being played. On each floor the stakes became increasingly higher, fortunes were lost, people were disfigured or ruined, but—with the exception of the top floor, which had dangerous games other than organ-gambling—at least no one died. They might need a face and body job after too many deformations, but those were easily obtained, although one had to have very good credit to ensure a proper job.

On each ascending level the house whores both male and female, became more exotic, erotic, grotesque and abundant. There were birdmen with feathers like peacocks and flamingos, children with dyed skin and overly large, implanted male and female genitalia, machines that spoke the language of love and exposed soft, fleshy organs, amputees and cripples, various drag queens and kings, natural androgynes and mutants, cyborgs, and an interesting, titillating array of genetically engineered mooncalves.

But none disturbed Pfeiffer as had that silly furry boy. He wondered if indeed the boy was still following him.

"Come on, Joan," Pfeiffer said impatiently. "I really don't want to waste any more time down here."

"But I always thought it was the expectation that's so exciting to seasoned gamblers," Joan said.

"Not to me," Pfeiffer said, ignoring the sarcasm. "I want to get it over with." With that, he left the room.

Then why bother at all? Joan asked herself, wondering why she had let Pfeiffer talk her into coming here. *He doesn't need me. Damn him,* she thought, ignoring a skinny, white-haired man and a piebald doggie mooncalf coupling beside her in an upright position.

She took a lift to the top level to catch up with Pfeiffer.

It was like walking into the foyer of a well-appointed home. The high walls were stucco and the floor was inlaid parquet. A small Dehaf rug was placed neatly before a desk behind which beamed a man of about fifty, dressed in camise and caftan.

He had a flat face, a large nose that was wide, but had narrow nostrils, and close-set eyes roofed with bushy, brown eyebrows the color his hair would have been had he had any.

Actually, the room was quite small, which made the rug look larger and gave the man a commanding position.

"Do you wish to watch or participate, Monsieur Pfeiffer?" he asked, seeming to rise an inch from the chair as he spoke.

"I wish to play," Pfeiffer said, standing upon the rug as if he had to be positioned just right to make it fly.

"And does your friend wish to watch?" the man asked, as Joan crossed the room to stand beside Pfeiffer. "Or will you give your permission for Miz Otur to become telepathically connected to you?" His voice didn't rise as he asked the question.

"I beg your pardon?"

"A psyconnection, sir." With a psyconductor —a note of condescension crept into his voice.

"I *know* what it is, and I don't want it," Pfeiffer snapped and then moved away from Joan. But a cerebral hook-in was in fact just what Joan had hoped for.

"Oh, come on," Joan said. "Let me in."

"Are you serious?" he asked, turning toward her. Caught by the intensity of his stare, she could only nod. "Then I'm sorry. I'm not a window for you to stare through."

That stung her, and she retorted, "Have you ever done it with your wife?" She immediately regretted her words.

The man at the desk cleared his throat politely. "Excuse me, monsieur, but are you aware that *only* games *organe* are played in these rooms?"

"Yes, that's why I've come to your house."

"Then you are perhaps not aware that all our games are conducted with psyconductors on this floor."

Pfeiffer, looking perplexed, said, "Perhaps you had better explain it to me."

"Of course, of course," the man said, beaming, as if he had just won the battle and a fortune. "There are, of course, many ways to play and, if you like, I can give you the address of a very nice house nearby where you can play a fair, safe game without hook-ins. Shall I make a reservation for you there?"

"Not just yet." Pfeiffer said, resting his hands, knuckles down, upon the flat-top Louis XVI desk.

His feet seemed to be swallowed by the floral patterns of the rug, and Joan thought it an optical illusion, this effect of being caught before the desk of the casino captain. She felt the urge to grab Pfeiffer and take him out of this suffocating place.

Instead, she walked over to him. Perhaps he would relent just a little and let her slide into his mind.

"It is one of our house rules, however," said the man at the desk, "that you and your opponent, or opponents, must be physically in the same room."

"Why is that?" Joan asked, feeling Pfeiffer scowling at her for intruding.

"Well," he said, "it has never happened to us, of course, but cheating has occurred on a few long-distance transactions. Organs have been wrongly lost. So we don't take any chances. None at all." He looked at Pfeiffer as he spoke, obviously sizing him up, watching for reactions. But Pfeiffer had composed himself, and Joan knew that he had made up his mind.

"Why must the game be played with psyconductors?" Pfeiffer asked.

"That is the way we do it," said the captain. Then, after an embarrassing pause, he said, "We have our own games and rules. And our games, we think, are the *most* interesting. And we make the games as safe as we can for all parties involved."

"What do you mean?"

"We—the house—will be observing you. Our gamesmaster will be telepathically hooked in, but, I assure you, you will not sense his presence in the least. If anything should go wrong, or look as if it might go wrong, then *pfft*, we intercede. Of course, we make no promises, and there have been cases where—"

"But anything that could go wrong would be because of the cerebral hook-in."

"Perhaps this *isn't* the game for you, sir."

"You must have enough privileged in-

"I'm here because . . . well, if you must know . . . actually . . . I mean . . . because I kept the king hanging too long with the punch line."

formation on everyone who has ever played here to make book," Pfeiffer said.

"The hook-in doesn't work that way at all. And besides, we are contract-bound to protect our clients."

"And yourselves."

"Most certainly." The casino captain looked impatient.

"If both players can read each other's mind," Pfeiffer said to the captain, "then there can be no blind cards."

"Aha, now you have it, monsieur." At that the tension between Pfeiffer and the desk captain seemed to dissolve. "And indeed," the captain continued, "we have a modified version of chemin de fer, which we call blind shemmy. All the cards are played facedown. It is a game of control (and, of course, chance), for you must block out certain thoughts from your mind while, at the same time, tricking your opponent into revealing his cards. And that is why it would be advantageous for you to let your friend here connect with you."

Pfeiffer glanced toward Joan and said, "Please clarify that."

"Quite simply, while you are playing, your friend could help block your thoughts from your opponent with her own," said the captain. "But it does take some practice. Perhaps, it would be better if you tried a hook-in in one of our other rooms, where the stakes are not quite so high." Then the captain lowered his eyes, as if in deference, but in actuality he was looking at the CeeR screen of the terminal set into the antique desk.

Joan could see Pfeiffer's nostrils flare slightly. *The poor sonofabitch is caught,* she thought. "Come on, Carl, let's get out of here now."

"Perhaps you should listen to Miss Otur," the captain said, but the man must have known that he had Pfeiffer.

"I wish to play blind shemmy," Pfeiffer said, turning toward Joan, glaring at her. She caught her breath. If he lost, then she knew he would make certain that Joan lost something, too.

"I have a game of nine in progress," the captain said. "There are nine people playing and nine others playing interference. But you'll have to wait for a space. It will be quite expensive, as the players are tired and will demand some of your points for themselves above the casino charge for the play."

"How long will I have to wait?"

The captain shrugged, then said, "I have another man waiting, who is ahead of you. He would be willing to play a game of doubles. I would recommend you play him rather than wait. Like you, he is an amateur, but his wife, who will be connected with him, is not. Of course, if you wish to wait for the other..."

Pfeiffer accepted, and while he and Joan gave their prints to the various forms, the captain explained that there was no statute of limitations on the contract signed by all parties, and that it would be honored even by those governments that disapprove of this particular form of gambling.

Then the furry boy appeared, like an apparition, to take them to their room where they would be given time to practice and become acquainted.

The boy's member was slightly engorged, and Pfeiffer now became frightened. He suddenly thought of his mother and the obligatory hook-in service at her funeral. His skin crawled as he remembered her last filthy thoughts.

The furry boy led Joan and Pfeiffer into the game room, which smelled of oiled wood, spices, traditional tobacco, and perfume. There were no holos or decoration on the walls. Everything, with the exception of the felt top of the gaming table, cards, thick natural carpet, computer consoles and cowls, was made of precious woods: oak, elm, cedar, teak, walnut, mahogany, redwood, ebony. The long, half-oval gaming table, which met the sliding partition wall, was made of satinwood, as were the two delicate, but uncomfortable, high-backed chairs placed side by side. On the table before each chair was a psyconductor cowl, each one sheathed in a light, silvery mask.

"We call them poker faces," the boy said to Pfeiffer as he placed the cowl over Joan's head. He explained how the psyconductor mechanism worked, then asked Pfeiffer if he wished him to stay.

"Why should I want you to stay?" Pfeiffer asked, but the sexual tension between them was unmistakable.

"I'm adept at games of chance. I can redirect your thoughts—without a psyconductor." He looked at Joan and smiled.

"Put the mechanism on my head and then please leave us," Pfeiffer said.

"Do you wish me to return when you're finished?"

"If you wish," Pfeiffer replied stiffly, and Joan watched his discomfort. Without saying a word, she had won a small victory.

The boy lowered the cowl over Pfeiffer's head, made some unnecessary adjustments, and left reluctantly.

"I'm not at all sure that I want to do this," Pfeiffer mumbled, faltering.

> *She was looking for any blister, crack, any anomaly in the smooth surface. He would gamble his body away without her, unless she was able to break through his defenses.*

Well, Joan said, "we can easily call off the game. Our first connection is just practice—"

"I don't mean the game. I mean the psy connection."

Joan remained silent. Dammit, she told herself, I should have looked away when Pfeiffer's furry pet made a pass at him.

"I was crazy to agree to such a thing in the first place."

"Shall I leave?" Joan asked. "It was *you* who insisted that I come along, remember?" She stood up, but did not judge the distance of the cowl/console connections accurately, and the cowl was pulled forward, bending the silvery mask.

"I think you're as nervous as I am," Pfeiffer said appeasingly.

"Make the connection right now. Or let's get out of here." Joan was suddenly angry and frustrated. *Do it,* she thought to herself, and for once she was not passive. Certainly not passive. *Damn him and his furry boy!* She snapped the wooden toggle switch, activating both psyconductors, and was thrust into vertiginous light. It surrounded her, as if she could see in all directions at once. But she was simply seeing through Pfeiffer's eyes. Seeing herself small, even in his eyes, small.

After the initial shock, she realized that the light was not brilliant, on the contrary, it was soft and diffused.

But this was no connection at all. Pfeiffer was trying to close his mind to her. He appeared before her as a smooth, perfect, huge sphere. It slowly rotated, a grim, gray planet, closed to her, forever closed.

Are you happy now? asked Pfeiffer, as if from somewhere deep inside the sphere. It was so smooth, seamless. *He really doesn't need me,* she thought, and she felt as if she were flying above the surface of his closed mind, a winged thing looking for any discontinuity, any fault in his defenses.

So you see, Pfeiffer said, exulting in imagined victory, *I don't need you.* The words came wreathed in an image of a storm rolling angrily over the planet.

She flew, in sudden panic, around his thoughts, like an insect circling a source of light. She was looking for any blister or crack, any anomaly in the smooth surface. He would gamble his body away without her, that she knew, unless she could break through his defenses, prove to him how vulnerable he really was.

So you couldn't resist the furry boy, could you? Joan asked, her thoughts like smooth sharks swimming through icy water. *Does he, then, remind you of yourself, or do I remind you of your mother?*

His anger and exposed misery were like flares on the surface of the sun. In their place remained an eruption on Pfeiffer's smooth protective surface. A crack in the cerebral egg.

Joan dove toward the fissure, and then she was inside Pfeiffer—not the outside of his senses where he could verbalize a thought, see a face, but in the dark, prehistoric places where he dreamed, con

ceptualized where he floated in and out of memory, where the eyeless creatures of his soul dwelled.

It was a sliding, a slipping in, as if one had turned over inside oneself, and Joan was sliding, slipping on ice. She found herself in a dark world of grotesque and geometric shapes, an arctic world of huge icebergs floating on a fathomless sea.

And for an instant, Joan sensed Pfeiffer's terrible fear of the world.

Mindfucker! Pfeiffer screamed, projecting the word in a hundred filthy, sickening images, and then he smashed through Joan's defenses and rushed into the deep recesses of her mind. He found her soft places and took what he could.

All that before the psyconnection was broken. Before the real game began. As if nothing had happened.

A man and woman, wearing identical cowled masks, sat across from Joan and Pfeiffer. The partition wall had been slid back, revealing the oval shape of the gaming table and doubling the size of the wood-paneled room. The dealer and the gamesmaster sat on each side of the long table between the opponents. The dealer was a young man with an intense, roundish face and straight black hair cut at the shoulders; he was most likely in training to become a gamesmaster.

The gamesmaster's face was hidden by a black cowl; he would be hooked in to the game. He explained the rules, activated the psyconductors, and the game began. Joan and Pfeiffer were once again hooked in, but there was no contact, as yet, with the man and woman across the table.

Pfeiffer cleared his mind, just as if he were before lasers or giving an interview. He had learned to cover his thoughts, for, somehow, he had always felt they could be seen, especially by those who wanted to hurt him politically and on the job.

White thought, he called it, because it was similar to white noise.

Pfeiffer could feel Joan circling around him, like the wind. Although he couldn't conceal everything, he could hide from her. He could use her, just as she could use him — had used him. They had reached an accord via mutual blackmail. Somehow, during their practice hook-in, Joan had forced herself into Pfeiffer's mind; shocked, he attacked her.

So now they knew each other better.

They built a simple symbol structure. He was the world, a perfect sphere without blemish, made by God's own hands, a world as strong and divine as thought, and she was his atmosphere. She contained all the elements that could not exist on his featureless surface. She was the protective cloak of his world.

They built a mnemonic in which to hide, yet they were still vulnerable to each other. But Pfeiffer guessed that Joan would remain passive—after all, she always had.

'Pssst! Sperm from a Nobel prizewinner?'

She also had the well-developed conscience of a mystical liberal, and she was in love with him. He had seen that—or thought he had.

She would not expose him to danger.

Pfeiffer congratulated himself for being calm, which reinforced his calmness. Perhaps it was Joan's presence. Perhaps it was the mnemonic. But perhaps not. He had the willpower; this was just another test. He had managed to survive all the others, he told himself.

Joan rained on him, indicating her presence, and they practiced talking within geometric shapes as a protective device—it was literally raining geodesic cats and dogs.

When the gamesmaster opened the psyconductor to all involved, Joan and Pfeiffer were ready.

But they were not ready to find exact duplicates of themselves facing them across the table. The doppelgängers, of course, were not wearing cowls.

"First, mesdames and messieurs, we draw the wager," said the dealer who was not hooked in. The gamesmaster's thoughts were a neutral presence. "For each organ pledged, there will be three games consisting of three hands to a game," continued the dealer. "In the event that a player wins twice in succession, the third hand or game will not be played." His voice was an intrusion; it was harsh and cold and came from the outside where everything was hard and intractable.

How do they know what we look like? Pfeiffer asked, shaken by the hallucination induced by his opponents.

But before Joan could reply, he answered his own question. *They must be picking up subliminal stuff.*

The way we perceive ourselves, Joan said. The doppelgängers became hard and ugly, as if they were being eroded by time. And Joan's double was becoming smaller, insignificant.

If we can't cover up, we won't have a chance.

You can't cover everything, but neither can they, Joan said. *It cuts both ways.* She noticed a fissure in the otherwise perfect sphere below, and she became black fog, miasma, protective covering. Pfeiffer was afraid, and vulnerable. But she had to give him credit. He was not hiding it from her, at least. That was a beginning.

Did you pick up anything from them, an image, anything? Pfeiffer asked.

We've been too busy with ourselves. We'll just wait and be ready when they let something slip out.

Which they will, Pfeiffer said, suddenly confident again.

From deep inside their interior, symbolized world, Joan and Pfeiffer could look into the external world of croupier, felt-top table, cards, wood-covered walls, and masked creatures. This room was simply a stage for the play of thought and image.

Pfeiffer was well acquainted with this

sensation of perceiving two worlds, two levels inside and outside He often awakened from a nightmare and found himself in his living room or library He knew that he was wide awake and yet he could still see the dream unfurl before him, watch the creatures of his nightmare stalk about the room—the interior beasts let loose into the familiar, comforting confines of his waking world Those were always moments of terror, for surely he was near the edge then and could fall

The dealer combined two decks of cards and placed them in a shoe, a box from which the cards could be slid out one by one He discarded three cards the traditional burning of the deck

Then he dealt a card to Pfeiffer and one to his opponent Both cards landed faceup A queen of hearts for Pfeiffer A nine of hearts for his opponent

So Pfeiffer lost the right to call the wager

Just as the object of blackjack was to draw cards that add up to twenty-one or as near to that figure as possible the object of blind shemmy was to draw cards that add up to nine Thus face cards, which would normally be counted as ten were counted as zero Aces normally counted as eleven, became one and all other cards had their normal pip (or face) value with the exception of tens which, like aces were counted as one

"Monsieur Deux wins nine over zero said the dealer looking now at Pfeiffer's opponent Pfeiffer was Monsieur Un and his opponent Monsieur Deux only because of their positions at the table

A hell of a way to start Pfeiffer said

Keep yourself closed Joan said turning into mist then dark rain, pure sunlight and rainbows a perceptual kaleidoscope to conceal Pfeiffer from his enemies *Look now, he'll be more vulnerable when he speaks I'll cover you*

Your choice said the gamesmaster The thought was directed to Pfeiffer's opponent who was staring intently at Pfeiffer

Look now Joan said to Pfeiffer

"Since we both turned up hearts perhaps that is where we should begin" Pfeiffer's opponent said speaking for the benefit of the dealer His words felt like shards of glass to Pfeiffer They're the seats of our emotions so we'd best dispose of them quickly Pfeiffer felt the man smile "Do you assent?

"It's your choice" Pfeiffer said to the dealer tonelessly

Don't let anything out, Joan said

Pfeiffer couldn't pick up anything from his opponent and the woman with him they were both empty doppelgangers of himself and Joan *Pretend that nothing matters* she said *If you expect to see his cards and look inside him for weakness you must be removed*

She's right Pfeiffer thought He tried to relax smooth himself down he thought innocuous white thoughts and ignored the knot of anxiety that seemed to be pulling at his groin

"*Cartes*" said the dealer dealing two cards from the shoe facedown one for Pfeiffer the other for his opponent Another two cards and then a palpable silence not even thoughts seemed to cut the air It was an unnatural waiting

Pfeiffer had a natural nine a winning hand (a queen and a nine of diamonds), and he looked up about to turn over his cards, when he saw the furry boy sitting across the table from him

What the hell—

Call your hand Joan said, feeling his glands open up a warm waterfall of fear But before Pfeiffer could speak his opponent said "My friend across the table has a natural nine A queen and a nine both diamonds Since I called his hand—and I believe I am correct then"

The dealer turned Pfeiffer's cards over and said "Monsieur Deux is correct and wins by call" If Pfeiffer's opponent had been mistaken about the hand Pfeiffer would have won automatically even if his opponent held better cards

The dealer then dealt two more cards from the shoe

You're supposed to be covering my thoughts, Pfeiffer said but he was composed thinking white thoughts again

I'm trying, Joan said *But you won't trust me you're trying to cover yourself from me as well as your opponent What the hell am I supposed do?*

I'm sorry Pfeiffer thought

Are you really so afraid that I'll see your true feelings?

This is neither the time nor the place His rhythm of white thought was broken Joan became a snowstorm aiding him lulling him back to white blindness *I think the gamesmaster is making me nervous having him hooked in privy to all our thoughts*

Forget the gamesmaster and for God's sake, stop worrying about what I'll see I'm on your side

"Monsieur Un, will you *please* claim your cards" said the dealer The gamesmaster nodded at Pfeiffer and thought neutral papery thoughts

Pfeiffer turned up the edges of his cards He had a jack of diamonds—which counted as zero—and a two of spades He would need another card

Don't think about your cards Joan exclaimed *Are you picking up anything from the other side of the table?*

Pfeiffer listened as if to his own thoughts He didn't raise his head to look at his opponent for seeing his own face—or that of the furry boy's—staring back at him from across the table was disconcerting and fascinating An image of an empty hollow woman without any organs formed in his mind He imagined her as a bag somehow formed into human shape

Keep that Joan said *It might be usable But I can't see his cards*

Just wait awhile Keep calm

Does Monsieur wish another card?" the dealer asked Pfeiffer. Pfeiffer took another card, and so did his opponent.

Pfeiffer had no idea what cards his opponent was holding. It promised to be a blind play. When the cards were turned over, the dealer announced, "Monsieur Deux wins, six over five." Pfeiffer had lost again.

I'm playing blind, Pfeiffer said anxiously to Joan.

He couldn't see your cards, either, she replied.

But that gave him little satisfaction, for by losing the first two hands, he had lost the first game.

And if he lost the next game, he would lose his heart, which, white thought or not, seemed to Pfeiffer to be beating in his throat.

Try to calm yourself, Joan said, *or you'll let everything out. If you trust me, and stop throwing up your defenses, maybe I can help you. But you've got to let me in, as it is, you're giving our friends quite the edge. Let's make a merger . . . a marriage.* But Pfeiffer was in no mood for irony. His fear was building, steadily, slowly.

You can fold the game, Joan said. *That is an alternative.*

And give up organs I haven't yet played for! The smooth surface of Pfeiffer's sphere cracked, and Joan let herself be swallowed into it. The surface of the sphere changed, grew mountain chains, lush vegetation, flowers, deserts, all the mingled moods of Joan and Pfeiffer.

Pfeiffer was no longer isolated; he was protected, yet dangerously exposed. Inside him, in the human moist dark, Joan promised not to take advantage of him. She caught a fleeting thought of Pfeiffer's dead mother, who had been a fleshy, big-boned, flat-faced woman. She also saw that Pfeiffer hated his mother, as much now as when she was alive.

In the next hand—the opening hand of the second game—Pfeiffer held a five of clubs and a two of spades, a total of seven points. He would not take another card unless he could see his opponent's. But when he looked up, Pfeiffer saw the furry boy who blew him a kiss.

You're exposed again, Joan said, and they thought themselves inside their world, thought protective darkness around themselves, except for one tiny opening through which to see into their enemies.

Concentrate on that image of the empty woman, Joan said to Pfeiffer. *She has to be Monsieur Deux's wife or woman. I can't quite visualize it as you did.* But Pfeiffer was trying to smooth down his emotions and the dark, dangerous demon that was his memory. The image of the furry boy sparked memories, fears, guilts. Pfeiffer remembered his father, who had been a doctor. There was always enough money, but his father extracted emotional dues for every dollar he gave his son. And, as a result, the young Pfeiffer had recurrent nightmares that he was sucking off his father. Those nightmares began again after his mother died. She had seen that homosexual fantasy when Pfeiffer hooked in to her on her deathbed.

Pfeiffer still had those nightmares.

And now, against his will, the image of him sucking off the furry boy passed through his mind, drawing its train of guilt and revulsion. The boy and his father, somehow one and the same.

You're leaking, Joan said, her thoughts an icestorm. She could see her way into Pfeiffer now, into those rooms of buried memories. Rather than rooms, she thought of them as subterranean caverns; everything inside them was intact, perfect, hidden from the harmful light and atmosphere of consciousness. Now she knew him.

Pfeiffer collected himself and peered into his opponent's mind. He thrust the image of the organless woman at the man.

It was like tearing a spiderweb.

Pfeiffer felt the man's pain as a feather touching flesh. The organless woman was Monsieur Deux's permanent wife. Pfeiffer had broken through and into his thoughts; he could feel his opponent's name, something like Gayah, Gahai, Gayet, that was it, and his wife was used up. Gayet saw her in the darkness of his unconscious, as an empty bag. She was a compulsive gambler, who had spent her organs, and Gayet hated gambling, but she possessed him, and he hated her and loved her, and was just beginning his self-destructive slide.

Now she was using him up. She was gambling *his* organs.

She's used up, Pfeiffer thought at Gayet. But Pfeiffer could only glimpse Gayet's thoughts. His wife was not exposed.

Nor was she defenseless.

She thrust the image of the furry boy at Pfeiffer, and Pfeiffer felt his head being forced down upon the furry boy's lap. But it suddenly wasn't the furry boy anymore. It was Pfeiffer's father!

There was no distance now. Pfeiffer was caught, tiny and vulnerable.

Gayet and his wife were swallowing him, thoughts and all.

It was Joan who saved him. She pulled him away, and he became the world again, wrapped in snow, in whiteness. He was safe again, as if inside Joan's cold womb.

Look now, Joan said an instant later, and like a revelation, Pfeiffer saw Gayet's cards, saw them buried in Gayet's eyes with the image of his aging wife. In that instant, Pfeiffer saw into Gayet and forgot himself. Gayet's wife was named Grace, and she had been eroded from too many surgeries, too many deformation games. She was his Blue Angel (yes, he had seen the ancient film) and Gayet the fool.

The fool held an ace of hearts and a five of diamonds.

Now Pfeiffer felt that the odds were with him. It was a familiar sensation for gamblers, a sense of harmony, of being a benevolent extension of the cards. No anger.

and now, it—with the inhuman side of the news

no fear, no hate, just victory. Pfeiffer called Gayet's hand, thereby preventing Gayet from drawing another card, such as a lucky three, which would have given him a count of nine.

Pfeiffer won the hand, and he thanked Joan. His thoughts were of love, but his repertoire of images was limited. Joan was now part of his rhythm and harmony, a constant presence, and she dreamed of the victorious cats that padded so gracefully through the lush vegetation of Pfeiffer's sphere—the cats that rutted, then devoured one another.

Pfeiffer won the next hand to take the second game. Pfeiffer and his opponent were now even. The next game would determine the outcome. Pfeiffer felt that calm, cold certainty that he would take Gayet's heart. The obsession to expose and ruin his opponent became more important than winning or losing organs; it was bright and fast flowing, refreshing as water.

He was in a better world now, a more complete, fulfilling plane of reality. All gamblers dreamed of this: losing or winning everything, but being inside the game. Even Joan was carried away by the game. She, too, wanted to rend—to whittle away at the couple across the table, take their privacies, turn over their humiliations like worry beads. They were Pfeiffer's enemies, and his enemies were her own.

Everyone was exposed now, battle-weary, mentally and physically exhausted, yet lost in play. Lost in perfect, concentrated time. Pfeiffer could see Gayet's face both as Gayet saw himself and as Grace saw him. A wide nose, dark complexion, low forehead, large ears, yet it was a strong face, and handsome in a feral, almost frightening way—or so Grace thought. Gayet saw himself as weak; the flesh on his face was too loose.

Gayet was a failure, although he had made his career and fortune in the Exchange. He had wanted to be a mathematician, but he was lazy and lost the "knack" by twenty-five.

Gayet would have made a brilliant mathematician, and he knew it.

And Grace was a whore, using herself and everyone else. Here was a woman with great religious yearnings, who had wanted to join a religious order, but was blackballed by the cults because of her obsession for gambling and psyconductors. But Pfeiffer could see into her only a little. She was a cold bitch and, more than any of the others, had reserves of strength.

This last game would be psychological surgery. Tearing with the knife, pulping with the bludgeon. Pfeiffer won the first hand. This was joy, so many organs to win or lose, so little time.

Pfeiffer lost the next hand. Gayet exposed Joan, who revealed Pfeiffer's cards without realizing it. Gayet had opened her up, penetrated all that efficiency and order to expose anger and lust and uncontrolled oceanic pity. Joan's emotions writhed and

crawled over her like beautifully colored, slippery snakes. Pfeiffer had been too preoccupied to protect her.

Joan's first uncontrolled thought was to revenge herself on Pfeiffer, expose him, but he opened up to her, buried her in white thought which was as cold and numbing as ice and apologized without words, but with the soft rounded comforting thoughts he equated with love. She couldn't trust him, nor could she expose him. Right now she could only accept him.

The dealer gave Pfeiffer a three of diamonds and an ace of clubs. That gave him only four points, he would have to draw again. He kept his thoughts from Joan, for she was covering him. She could attack Gayet and his whore, expose them for their cards. Gayet's heart was not simply his organ—not now, not to Pfeiffer. It was his whole life, life itself. To rip it away from him would be to conquer life, if only for a moment. It was life affirming. It was being alive. Suddenly he thought of his father.

Close yourself up. Joan said. *You're bleeding.* She did not try to penetrate his thoughts, that would have exposed Pfeiffer even more dangerously.

Help me, Pfeiffer asked Joan. This hand would determine whether he would win or lose the game . . . and his heart.

Once again she became his cloak, his atmosphere, and she weaved her icy threads of white thought into his.

This was love, she thought.

Pfeiffer couldn't see Gayet's cards and nervously asked Joan to do something. Gayet was playing calmly, well covered by Grace, who simply hid him. No extravagance there.

Joan emptied her mind, became neutral, yet she was a needle of cold, coherent thought. She prodded, probed, touched her opponents' thoughts. It was like swimming through an ever-changing world of dots and bars, tangible as iron, fluid as water. It was as if Gayet's and Grace's thoughts were luminous points on a fluorescent screen.

And still she went unnoticed.

Gayet was like Pfeiffer. Joan thought. Seemingly placid, controlled, but that was all gingerbread to hide a weak house. He was so much weaker than Grace, who was supporting and cloaking him. But Grace was concentrating her energies on Gayet, and she had the fever, as if she were gambling her own organs once again.

Undoubtedly, Grace expected Joan and Pfeiffer to go straight for Gayet, who had read the cards.

So Joan went for Grace, who was in the gambler's frenzy as the hand was being played. Joan slipped past Grace's thoughts, worked her way into the woman's mind, through the dark labyrinths and channels of her memory, and into the dangerous country of the unconscious. Invisible as air, she listened to Grace, read her, discovered. A sexual miasma. Being brutally raped as a child. After a riot in Manosque. Raped in a closet, for God's sake. The man tore her open with a rifle barrel, then inserted himself. Taking her piece by bloody piece, just as she was taking Gayet. Just as others had taken her in rooms like this, in this casino, in this closet.

And Gayet, now Joan could see him through Grace, unperturbable Gayet, who had so much money and so little life, who was so afraid of his wife's past, of her lovers and liberations he called perversions. But he called *everything* a perversion.

How she hated him beneath what she called love.

But he looked just like the man who had raped her in that closet so long ago. She could not remember the man's face—so effectively had she blocked it out of her mind—yet she was stunned when she first met Gayet. She felt attracted to him, but also repelled, she was in love.

Through Joan, Pfeiffer saw Gayet's cards, a deuce and a six of clubs. He could call his hand, but he wasn't sure of the deuce. It looked like a heart, but it could just as easily be a diamond. If he called it wrong, he would lose the hand, and his heart.

I can't be sure, Pfeiffer said to Joan, expecting help.

But Joan was in trouble. Grace had discovered her, and she was stronger than Joan had ever imagined. Joan was trapped inside Grace's mind, and Grace, who could not face what Joan had found, denied it.

And snapped.

In that instant, Joan felt that *she* was Grace. She felt all of Grace's pain and the choking weight of memory, as souls and selves incandescently merged. But before Joan and Grace could fuse inescapably, Joan recoiled, realizing that she was fighting for her life. She screamed for the gamesmaster to deactivate the game. But her screams were lost as Grace instantly slipped into the gamesmaster's mind and caught him, too. She had the psychotic's strength of desperation, and Joan realized that Grace would kill them all rather than face the truth about herself and Gayet.

Furiously Grace went after Pfeiffer. To kill him. She blamed him for Joan's presence, and Joan felt crushing pain, as if she were being buried alive in the dirt of Grace's mind. She tried to wrench herself away from Grace's thoughts, lest they intertwine with, and become, her own.

She felt Grace's bloodlust . . . her need to kill Pfeiffer.

Grace grasped Pfeiffer with a thought, wound dark filaments around him that could not be turned away by white thought or anything else.

And like a spider, she wrapped her prey in darkness and looked for physiological weakness, any flaw, perhaps a blood vessel that might rupture in his head.

Joan tried to pull herself away from the pain, from the concrete weight crushing her. Ironically, she wondered if thought had mass. What a stupid thought to die with, she told herself, and she suddenly remembered a story her father had told her about a dying rabbi who was annoyed at the minyan praying around him because he was trying to listen to two washerwomen gossiping outside.

Many years later, her father confessed to her that it wasn't really a Jewish story at all; it was Buddhist. She held on to that thought, remembered how her father had laughed after his confession.

The pain eased as she followed her thoughts. If thought had mass . . .

She was thinking herself free, escaping Grace by finding the proper angle, as if thought and emotion and pain were purely mathematical.

That done in an instant.

But if she were to save Pfeiffer's life, and her own, she would have to do something immediately. She showed Grace her past. Showed her that she had married Gayet because he had the face of the man who had raped her as a child.

Gayet, seeing this, too, screamed. How he loathed Grace, but not nearly as much as she loathed herself. He had tried to stop Grace, but he was too weak. He, too, had been caught.

As if cornered, as if she were back in the closet with her rapist, she attacked Gayet. Only now she had a weapon. She thought him dead, trapped him in a scream, and, as if he were being squeezed from the inside, his blood pressure rose. She had found a weakened blood vessel in his head and it ruptured.

The effort weakened Grace, and a few seconds later the gamesmaster was able to regain control and disconnect everyone. Gayet was immediately hooked in to a life-support unit which applied CPR techniques to keep his heart beating.

But he was dead.

There would be some rather sticky legal complications, but by surviving, Pfeiffer had won the game, had indeed beaten Grace and won all of Gayet's organs.

As Pfeiffer gazed through the transparent walls of the transpod that whisked him and Joan out of Paris, away from its dangers and sordid delights, he felt something new and delicate toward Joan.

It was newfound intimacy and gratitude and love.

Joan, however, still carried the echoes of Grace's thoughts, as if a part of her had irreversibly fused with Grace. She too felt something new for Pfeiffer. Perhaps it was renewal, an evolution of her love.

They were in love . . . yet even now Joan felt the compulsion to gamble again. ☐☐

ROBOTS AT HOME

Mechanical majordomos and butlerbots are at your threshold

BY RICHARD WOLKOMIR

Ever wish you had a slave? Think of it—a serf to vacuum your floors, cook duck a *l'orange* for you and your friends, serve, clear the table, and wash the dishes. After the party, your slave would help you relax with a game of backgammon. And if your slave had the audacity to win, you could administer a punitive kick. Disgusting? Abhorrent? What if the price were right? What if everybody had one? And what if this slave were a thing of aluminum, plastic and integrated circuits?

Eventually, we all will have robot slaves. So inexorable is the evolution of industrial robots, say the experts, that household spin-offs are virtually inevitable. In fact, robotic majordomos are almost among us.

Joseph Engelberger, president of Unimation, Inc., the leading robot manufacturer, recently appeared on the Merv Griffin television talk show. With him was a Unimation robot, an intellectually feeble articulated arm. The robot stood in front of a conventional household window, complete with curtains. When Engelberger pressed a button, the robot opened the curtains, picked up a squeegee, washed the window, dried it, and put down the squeegee. Then it unlatched and opened the window, picked up a watering can, watered the petunias in their sill-top flower box, put down the watering can, and closed the window and curtains.

"The point," says Engelberger, "is that it has become exceptionally difficult these days to find a human housekeeper who'll do windows."

Lest anyone think the president of Unimation is kidding, at one end of his office in a white colonial house in Danbury, Connecticut, he recently installed a kitchen. "Within the next few years, I will have a robot in a closet

PAINTING BY ICHIRO TSURUTA

next to that kitchen" he says. The robot will be called Isaac, in honor of Isaac Asimov. However, the robot will not write books. It will be a domestic thrall.

Isaac, an articulated arm on wheels, is already in training at Unimation's research facility in California. It can roll 40 feet across a floor, find an assigned spot, and carry out programmed tasks. In one test at Engelberger's office, Isaac opened a cabinet, pulled out a mug, poured coffee into it, and then rang a bell to inform its boss that his coffee was ready. But Engelberger says that Isaac is still primitive and will require much tinkering before it takes its station in his office closet.

"In just three years, this will not necessarily be an entirely practical, useful device, but it will do enough to spark imagination," Engelberger says. "It will be under voice command, and it will take orders for coffee and Danish. It will be able to heat the Danish, get the cups and saucers, make the coffee, and serve it to my guests. And it will clean up afterward and put the dishes in the dishwasher on command. No tipping, of course. No need for a thank you or other pleasantries."

Isaac will not be the first domestic robot. An Urbana, Ohio, computer engineer named Charles Balmer already has built Avatar, Resembling a cross between R2D2 and a dental chair, Avatar is one of many homemades now clanking about in U.S. homes. Atari founder Nolan Bushnell's Androbot, Inc., is marketing two home robots. One is the Androbot, a radio-controlled automaton that dances and sings under instructions of a home computer. The second is BOB, a self-contained model with its own "brain-on-board." Hence BOB. And the Heath Company recently introduced Hero 1, a $2,495 robot ($1,500 in kit form) that carries up to a pound in its metal claw, "sees" (dimly), and performs such chores as delivering drinks and patrolling for burglars (see "Heath's Hero," Breakthroughs, January 1983). Encountering an intruder, Hero will raise its gripper and announce that it is calling the police, which should be sufficiently startling to straighten the hair of most prowlers. On the other hand, Hero's repertoire of tricks is limited. In fact, one of the 33 phrases it intones is "I do not do windows!" Heath expects Hero to be used chiefly as a teaching device for robotics students and experimenters.

"I don't think anything is now being done specifically to address the household robot market," says Joseph Engelberger. But Elliott Wilbur, an expert on housing and a vice-president at Arthur D. Little, Inc., the international consulting company, says that although he cannot reveal the details, one of his firm's big-corporation clients is currently experimenting with domestic robots.

Wilbur was one of nine Arthur D. Little experts in fields ranging from electronics to home appliances who met recently at *Omni*'s behest to consider the prospects for domestic robots. In a dining room at the prestigious think tank's Cambridge, Massachusetts, headquarters, over turkey salad, fruit, and sherry (served by humans), the consultants analyzed household robots as a potential product. They disagreed often sharply, on exactly how robots would fit into the home-appliances market. But they agreed on one important point. Developing the necessary technologies is not only feasible, but virtually inevitable. As engineers steadily boost the IQs of industrial robots, they are creating the technological bits and pieces that eventually will feed your Siamese, rake your leaves, and knot your cravat.

It will not be easy. Household robots must not drop the glasses or try to leave rooms through the wall; so they will require senses and abilities that today's industrial robots lack. To see how difficult it will be to develop those technologies, consider just one sense organ: the eye.

Donald L. Sullivan, an Arthur D. Little computer expert, is developing a robot inspector for industry. His machine looks at a product, such as a slice of bacon, sees the darker strips of meat and the lighter strips of fat, computes the fat percentage, and then either passes the slice along or tosses it in the reject bin. "Producing a digital image of merely a slice of bacon takes about seventy-six thousand numbers," he says. Sullivan's laboratory is a creative jumble of video cameras, microprocessors, and—a Salvador Dali touch—assorted slices of meat, pouches of sweet-and-sour pork, and crackers.

Robot vision, he explains, works by translating a video image into numerical values that a computer can understand. The system assigns a number to each shade of gray between black and white—the lighter the shade, the higher the number. To interpret a picture, it breaks down the image into dots, assigning an appropriate number to each dot. For the image of a bacon slice, for instance, the computer identifies all dots with values below a certain number as the dark background and those above a certain number as white fat. All of the numbers in between are seen as red meat.

Compared to wending its way, bump-free, through a house and cleaning the bathtub, it is simple for a robot to inspect bacon for fat, crackers for burns, or food pouches for leaky seals. Yet developing just one experimental inspection robot, Sullivan says, has cost about $70,000 in hardware and $300,000 in engineering time. He says that the far more sophisticated vision a household robot needs is four to nine years in the future.

Touch, too, is on its way. Researchers in Japan are developing hospital robots that can gently hoist a patient off his sickbed, deposit him in the bathtub, fish him out, and return him to bed. Within about three years, Australian engineers expect to have robots sufficiently sensitive to shear sheep, no Band-Aids needed.

"After my monologue could I have just a few minutes to promote my new book?"

Robots also must understand spoken commands. That technology is inevitable because it means a jumbo payoff in the office-automation field. IBM researchers, among others, have already developed a typewriter that takes dictation. It is s-l-o-w. Its computer requires 100 minutes to transcribe a sentence that took only 30 seconds to speak. But IBM's engineers predict they will have a practical prototype in a few years. According to David Lee, an Arthur D. Little expert on consumer products and appliances, "Voice recognition is well on its way, and that will help open up the domestic-robot market."

A household robot should speak, as well as hear. Already the "operator" giving New York City pay-phone users such messages as "Sixty cents, please" is a computer with a 70-word vocabulary. A decade or two hence, say robotics experts, when you tell your household Isaac to change the bulb in the bathroom lamp, it will answer, "Right on!" or, "At once, Your Magnificence!" or whatever response you have programmed into its memory. But don't expect Isaac to run off to perform its humble chore. It is more apt to roll.

A walking robot is possible, however, according to Robert B. McGhee, an Ohio State University electrical engineer, who has built a six-legged walking machine. With sensors in each foot, this metal cucumber beetle can even pick its way along a path littered with stumps. And at Carnegie-Mellon University's Robotics Institute, visiting scientist Ivan Sutherland is developing a six-legged robot vehicle. Carnegie-Mellon professors have even choreographed a dance for a robot and a woman.

Still, the first domestic robots are unlikely to lurch through your house on metal legs. "The wheel was one hell of an invention," says Engelberger. "There's a lot of fun in making walking machines, and they may be useful for going over rough terrain. But a house is not rough terrain."

He points out that Unimation's Isaac will roll through his office on three wheels with tires that swivel. These will enable the robot to move horizontally in any direction without turning its body. "It's as if a car could park by moving sideways," he says, adding that Isaac occupies no more floor space than Larry Csonka.

When will all these components come together? "My own conjecture," Engelberger says, "is that it will make economic sense for the luxury market by 1990." At their session on domestic robots, the Arthur D. Little consultants predicted that commercial models will make their debut a bit later, about the year 2000.

But the $64-billion question is this: Will anyone buy the things? As housing specialist Elliott Wilbur asks, "Why not just hire a kid to cut your grass?"

"Because there will be fewer kids to hire," responds Martin Ernst, a vice-president at the consulting company and an operations-research expert who believes dropping birth rates will reduce the supply of casual labor. He also believes that fewer adults will be interested in drudge work; on a recent trip to the Netherlands, he found that the entire country has only two commercial laundries because so few Dutch workers are willing to take such jobs.

And according to one authority, we *are* buying robots aplenty. Electronics engineer Stuart Lipoff told the Cambridge meeting: "We already have programmable microwave ovens, dishwashers, and swimming-pool cleaners. These devices are all robots of a sort, even if they don't have eyeballs."

The consensus at Arthur D. Little was that robots will develop along two tracks. First, our appliances will get smarter and smarter. "The cost of braininess is so low," pointed out Ernst, "that eventually the smart appliances will begin to merge."

"You might end up with a unit that combines a refrigerator and an oven," agreed appliances engineer David Lee. At a preset time, the freezer section would pop the dinner you punched in for tonight into the microwave section, which would turn itself on and off. The next step, according to Lee, will be an automated menu—choosing your dinners for the next month, perhaps—coupled with automatic inventory

"This is going to sound a little paranoid, I know, but has anyone ever noticed the striking resemblance between Santa Claus and Karl Marx?"

control based on robot readings of supermarket package codes

Donald Sullivan foresees a clutterless household in which the robot will store infrequently used gadgets in a central area "Let's say one night you come home in the mood to whip up a gourmet meal You could tell your kitchen 'Hey forget that frozen dinner I programmed for tonight and get me the Cuisinart It goes rumble rumble ptooey and up pops your Cuisinart" Sullivan even envisions a box of basic components that the robot might draw upon to assemble household mechanisms as required for different domestic jobs

On robot evolution's second track, engineers will be developing a stand-alone automaton to handle such odious chores as raking the lawn, cleaning the bathtub or reading a toddler s favorite story over and over Ultimately the stand-alone robot and the smart appliances might share a central brain that controls everything "You'll have the mechanical peripherals with modest intelligence and a basic computing engine that ties everything together," says Gordon Richardson an Arthur D Little robotics consultant Someday your entire house itself may be an intelligent robot that cares for its inhabitants

"Remember the brain doesn t have to reside in the robot it might even be shared by all the houses on a block" Engelberger notes He compares tomorrow s robot house to HAL the unseen computer that controlled the spaceship in *2001 A Space Odyssey* But he says it also will be necessary to have a stand-alone robot like C-3PO in *Star Wars* to handle chores like cleaning and to give people something to relate to However, while the robot is stacking dishes in the kitchen dishwasher its "brain may be humming in the basement And its 'eyes' may be mounted in the ceiling of each room

Eventually says Engelberger, in its servant's quarters the household robot will have spare parts for all the appliances in the house with a collection of tapes giving maintenance instructions "At night you'll tell the robot, 'The range isn't working so please fix it by morning'" While you sleep the robot is awake It is alert for intruders and fires of course but it is also operating on your range "If it gets stuck it calls the factory and talks to a smarter robot to find out what to do" says Engelberger If it lacks a part it orders it By the time robots have advanced to this stage, they also will keep your larder stocked, ordering replacement items from the supermarket to match your family's consumption

The repertoire of skills such a robot might master seems unlimited Wilbur suggests that robots will be even more salable if they replace skilled workers as well as low-priced laborers "For instance your robot should be able to cut your hair to any style you like" he suggests

Whatever form the robot takes built-in safety is critical "You'd hate to have a two-thousand-pound robot go berserk in your

living room," says robotics expert Richardson. Household robots will have to be at least as safe as highly trained guard dogs, observes Engelberger. "They might have a magnetic radiation aura around them or some sort of sensor to detect a baby in their path." Domestic robots, he adds, will certainly include in their programming the Three Laws of Robotics propounded decades ago by Isaac Asimov. A robot must not harm a human being, nor through inaction allow one to come to harm; a robot must always obey human beings, unless that is in conflict with the first law; a robot must protect itself from harm, unless self-protection undermines the intent of the first or second laws.

But will tomorrow's household slave actually be a machine? "The ultimate answer," says Wilbur, "may be to implant this intelligence in an animal, like a monkey." He suggests that a microprocessor collar might pulse out signals to guide the beast through chores that require more-than-simian brainpower. Nor is the idea of zoological slaves farfetched, considering that for eons mankind has exploited the muscles and brains of beasts from llamas to sheep dogs. At the Arthur D. Little meeting, computer expert John Langley cited the example of his milkman, who recently switched from a horse-drawn wagon to a truck and found that the animal was much more efficient because it directed itself down the street and knew all the stops.

The milkman just ran along behind the cart carrying the bottles to his customers' doors," Langley explains.

Researchers at the Tufts–New England Medical Center Hospital, in Boston, working under a National Science Foundation grant, are training monkeys to perform services for paralyzed people. The monkeys' chores include fetching food from the refrigerator, opening or locking a door with a key, removing a record from its album cover and placing it on the turntable, and brushing their owners' hair.

The first household robots may also debut as caretakers for invalids. Unimation, working with researchers at Stanford University, is attempting to modify a Puma robot, one of the company's standard models, to understand simple spoken commands so it can aid paraplegics. Martin Ernst points out that as the population ages, such services will be in growing demand. Another Arthur D. Little engineer, Richard Whelan, notes that nurse-robots could remind elderly patients to take their pills, monitor their masters' life signs, and alert medical services in emergencies. "Machines like this would allow people to remain independent and function on their own much longer," he says.

But robots may turn out to be more than mere workhorses. Psychologists and sociologists have been tracking what appears to be a growing epidemic of loneliness in Western society. They suspect that many of us in the future may buy robots to be our simulated sympathetic friends and companions.

"I think the first commercially viable item may turn out to be a robot pet, eventually even a robot lover. Don't forget the orgasmatron in Woody Allen's movie *Sleeper*," says engineer Stuart Lipoff.

But the first models would be fairly simple, with some artificial vision, some artificial voice, the ability to understand speech, and some movement. The robot wouldn't have to do much more than move around, blink its lights, respond in a playful way, and maybe wag a tail."

Soft and fuzzy, they could have built-in heating units, making them warm to the touch. Such robots might have therapeutic value in nursing homes, where patients are not permitted to have pets.

Will people really choose machines to be their buddies? "Go back to *Star Wars*," suggests Lipoff. "What were those two robot creatures really doing? They were not so much utilitarian machines as they were companions, friends."

You could do many things with your robot friend. Certainly you could play chess or checkers. Marvin Minsky, head of artificial-intelligence research at MIT, years ago created a robot dett enough to catch a baseball. And, as with any friend, you could have long, rambling personal dialogues with your robot. People were delighted to discuss their intimate problems with a computer "psychologist" program created at MIT not long ago.

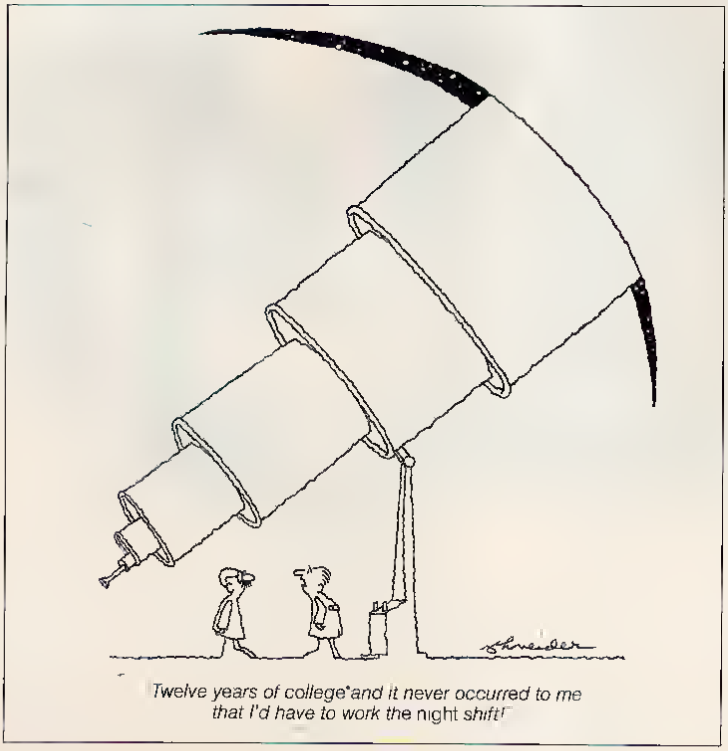
"If people already have trouble differentiating between their relationships with people and a machine, over the next decade or so, as we develop computers with ultrahigh-speed parallel processing, people may find conversations with a robot indistinguishable from talks with people," says Ernst. "They may even find the machines to be preferable."

Here we are, hardly settled into our electronic cottages, and already the age of electronic pals is upon us. Androbot's Nolan Bushnell painted a comforting picture of future friendships when he introduced his diminutive (three-foot-tall) home robot. While you wiggle a video-game joystick, making your aluminum sidekick dance a jig, it will speak to you, sing your favorite songs, or whisper Shakespearean sonnets in your ear—the very model of a learned and entertaining soul mate.

As Bushnell told reporters when he announced his new robot protegé: "We're talking about a someone, not a something—a friend that would greet you after a long day at the office."

What next? Bushnell predicts synthetic travel. You enter a control module in Duluth and take command of a robot in Rome, peering through its eyes, listening to live street sounds through its ears, as you send it lurching down the *Via Veneto*. (See "Travel by Proxy," "Antimatter.)

"It's a wonderful business," says Engelberger, "All things are possible." ∞

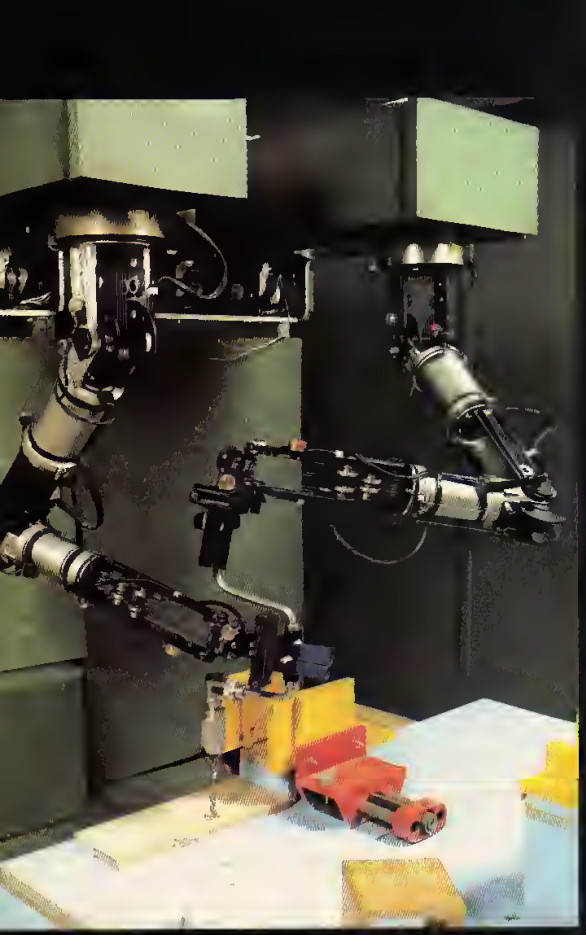


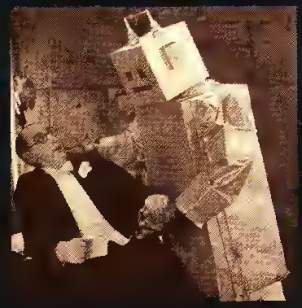
Twelve years of college and it never occurred to me that I'd have to work the night shift!

ROBOTS: FANTASIES AND REALITIES

BY MICHAEL EDELHART

Once the stuff of fantasy—both novels and SF films—robots have stepped out of fiction and into our lives. Robots entertain us. They work for us. They tantalize us with their potential as ever more talented (and strange-looking) automatons step out of





robotics laboratories all over the world. And since the mythical robot has helped shape our expectations, it is fascinating to take a good look at the robots of fact and see how well they measure up to the robots of fantasy.

One revered tradition, the robot as pseudohuman—an electromechanical copy of the human form—has been partially realized. The opening pages of this story exhibit one of the modern successes: the android entertainer. A Mark Twain robot, shown from two angles, without makeup and costume, was custom-built to entertain visitors to Walt Disney Enterprises' EPCOT Center. The Disney performer tells stories and makes gestures with uncanny realism. It also bears more than a passing resemblance to the Yul Brynner robot conceived for the SF film *Westworld* (inset photo).

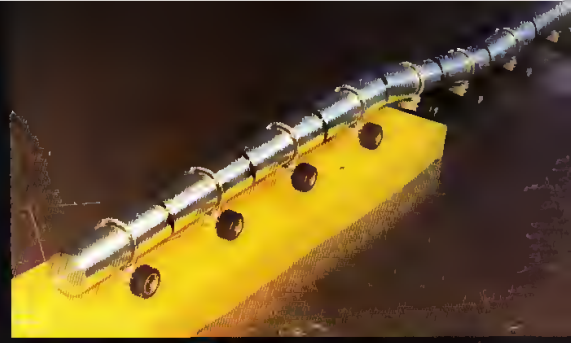
Android actors are equally popular in Japan, where eerily lifelike robot figures perform in large department stores. Some are Oriental humanoids garbed in traditional costume, while others assume Western identities. The

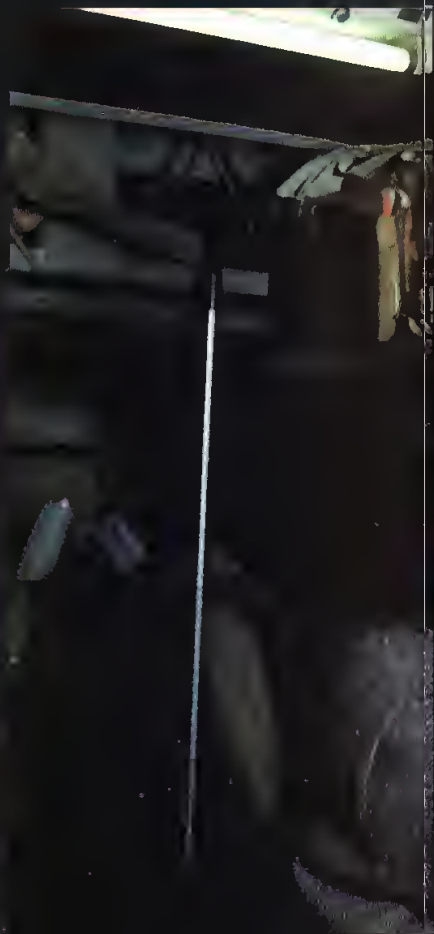
Overleaf: A robot Mark Twain bears an eerie resemblance to a fictional android from the movie Westworld. *Clockwise from near left, A typical movie robot compared to early robotic fingers, a Japanese robo-carpenter, and a Swedish industrial arm.*

mechanized figure shown on the following spread, when outfitted with the right wig and evening gown, does a creditable imitation of Marilyn Monroe. Japanese inventor Shunichi Mizuno, shown making adjustments on his Monroe-droid, plans soon to debut a robot/human theater troupe that will present plays with speaking parts performed by both humans and robots. Audiences may face the unusual challenge of trying to figure out which of the actors are flesh and blood and which are plastic and electronics.

Robots today, however, do much more than entertain. As a result, the long-cherished notion that the ideal robot is human in shape has proved much too simplistic. Our robot workers are anything but humanoid. Their eyes are laser scanners, their arms, bulky hydraulic lifters, their legs, really pneumatic

Filmdom's robot Gog (near right) looks somewhat crude when compared with the sleek lines of a real robot snake (far right) and two maxi- and mini robot arms (below right). Below: The image of an airplane as "seen" through digitized robo vision

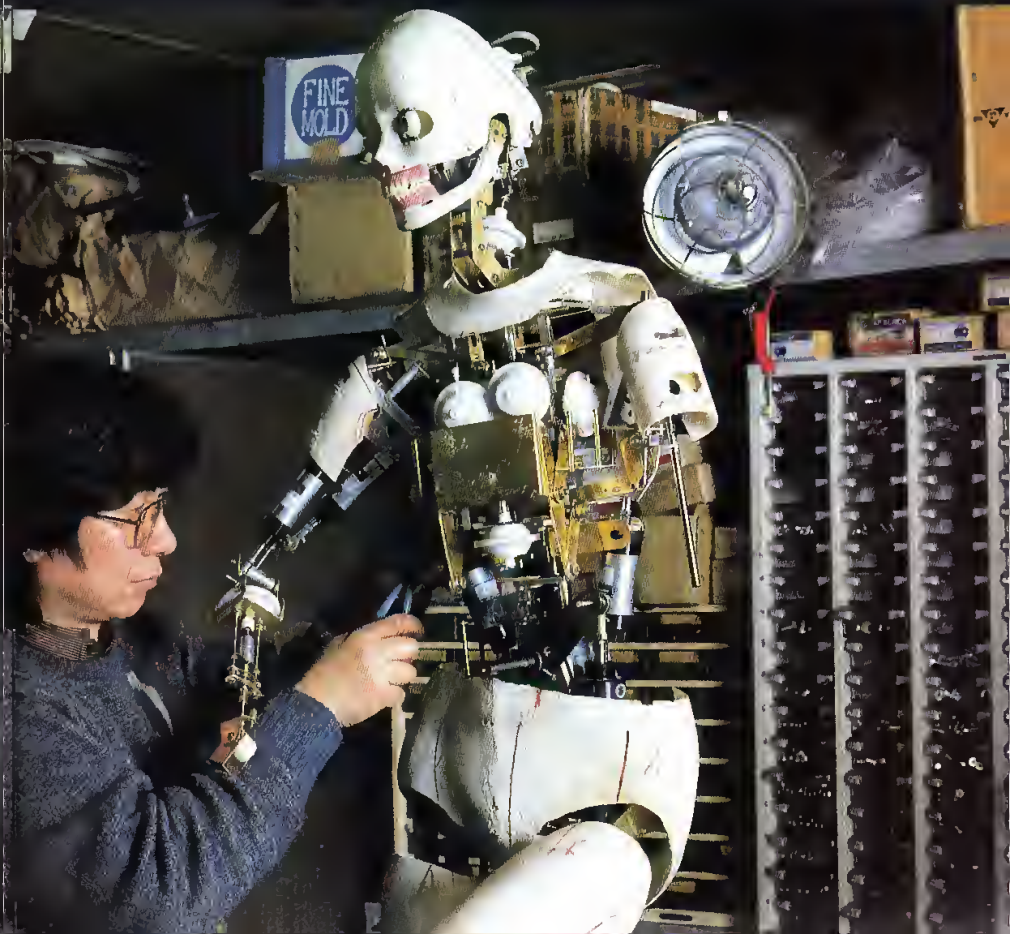


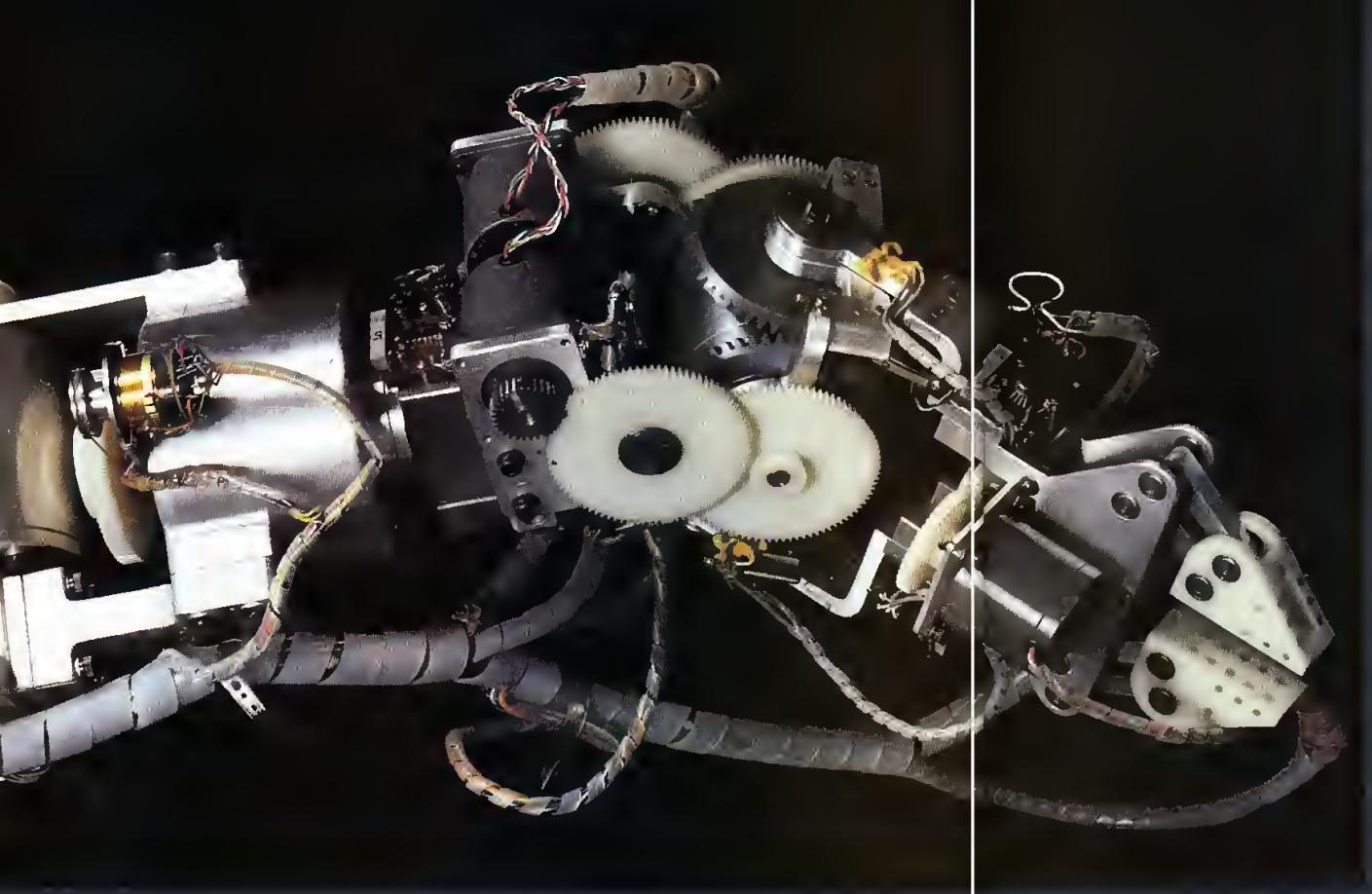


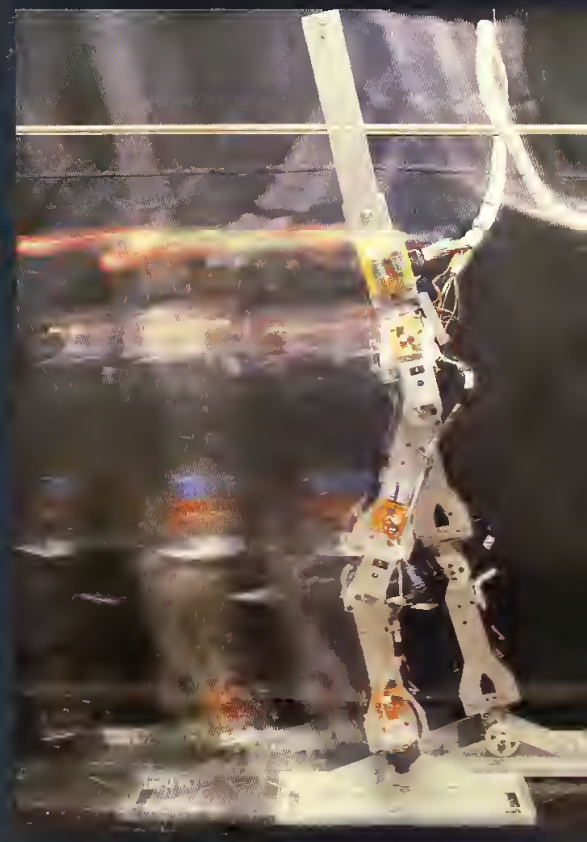
tubes anchored to the factory floor. Many of their skills are far from manlike. What they "see" is often merely a fuzzy, computer-digestible image of the world, such as the connect-the-dots type of digitized image on the previous page or a laser-scan contour map of an object's surface. By comparison the visual capabilities of an infant are light-years more sophisticated.

Fantasy and reality coexist most comfortably in the research centers where the next generation of robots is being spawned. Already a menagerie of exotic creatures, some more ingenious than anything Hollywood could have dreamed up, have been born. One Japanese scientist has designed an intelligent, four-legged robot spider (below left) that makes its way up and down stairs with elegant ease. Another of his countrymen has built several robot

Poor bedside manner of a movie robot nurse (near left) is contrasted with a calm robot patient used for medical training (far left). Japanese android (below) becomes Marilyn Monroe when dressed up. Spider robot (below left) climbs stairs by itself.

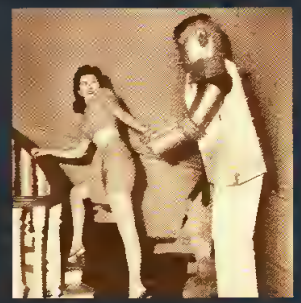






serpents that can gyrate and slither very much like their reptilian counterparts. Roboticists in the United States have been working on a new species of mobile robots that employ a rudimentary sense of touch and vision to negotiate the clutter of the real world with an unmachinelike ingenuity.

Many of the components needed to build the robot of our dreams already exist. What remains is the challenge of assembling the disparate parts into an intelligent entity. The end product of all this work is sure to both please and disappoint us. In many ways the robot of reality has turned out to be a more powerful and intelligent entity than the creature foreseen in robot mythology. At the same time, this machine is less friendly, less innately human in form and function, than any of our imaginings. Although born of human ingenuity, the robot already shows distinct signs of becoming an alien being. Humans may always view it with some degree of uneasiness. But then, who ever said that lasting relationships were supposed to be easy? OO



Robo-star Ivan the Mechanical Man (with friend, at right) lacked the highly adept robot arm (above) and advanced robot legs (above right) designed for today's machines. Laser scan (far right) shows how a human hand appears to the modern robot.

ROBO-SHOCK!

CONTINUED FROM PAGE 51

spray and laying down an enticing trail leading directly to the stairwell.

For management psychological disruption was the least of the problems caused by the robo-carts. Without learning the ropes by delivering the mail, "raw" clerical help now required months of training at high pay levels to learn what they previously picked up on the mail routes. Problems like these in the workplace probably indicate that it will be a while before robots win a permanent place in the home. On the domestic-robot scene, some experts predict we will see little more than robot guards for a few years. These will be fairly dumb rovers: they'll have all they can do to figure out where they're going. They will be able to detect the presence of people, but unable to distinguish between friend or foe. One robo-guard offered by Robotics International, Inc., of Jackson, Michigan, is based on the classic "motivated" rover principle. That is, this robot has only one objective—to move down hallways in search of electrical sockets. When it finds one, it recharges itself and trundles on to the next plug. For a sentry it seems slightly self-preoccupied.

But several other robots today appear equally egocentric—if not hypochondriacal—in monitoring the state of their health. "Diagnosis of robot problems should be the nearest thing to medical diagnosis," Grossman thinks. "Some doctors are good, some bad. The first thing a bad doctor does is run a zillion tests just for a start, when it might be something as simple as your necktie being too tight. It's the same with robot difficulties. The toughest thing is knowing in which subsystem to look for the trouble: electrical, electronic, hydraulic, software, mechanical, sensors." IBM's 7565 "robotics system," he tells us, monitors its entire state every 20 milliseconds. And if the self-examination finds anything abnormal, the machine shuts itself down and logs the problem.

Grossman remembers a test robot that fooled everyone for months. It kept turning itself off for no discernible reason. Finally someone received an electrical shock from it and realized there was a clogged hydraulic filter that someone had forgotten to replace. "It was trivial," Grossman says, "but when you pump hydraulic fluid through a filter at high speed it generates static electricity; the static electricity built up a charge and the charge shut off the computer." Robo-shock indeed.

At Battelle Memorial Institute in Columbus, Ohio, experts specialize in self-diagnostic systems applicable to robots. "It's not as spacey as it sounds," says Barry Brownstein, manager of the digital systems and technology section, "and there's lots of motivation for it." Reports indicate that the average robot has 400 hours mean time between failures. "Some problems are akin to human ills," says Brownstein, "but others are very different. You can't open up a person and implant health monitors everywhere. And you can't put too many of them in robots either, because the reason a lot of machinery goes down is sensor failure. Some robots have sensors for the sensors, a design idea that could, if carried far enough, compound the problems infinitely—loops within loops."

Brownstein and company are designing robot-to-human communication systems so that remote—lunar, undersea, nuclear plant—robots could report what is wrong with them to the guys back home, and the humans could respond with suggestions for compensating for the robots' problems. This design principle, says Brownstein, is called graceful degradation. In alien environments, most robotics experts believe the robots will have to be designed with self-repair and compensation components for breakdowns—or they will have to be designed to be thrown away.

"If robots are to expand beyond fairly focused applications," Brownstein continues, "much must be done to improve reliability and to involve relatively unskilled people in care and maintenance. We want these machines suitable for people already in the environment, instead of trying to make a superclass of robot doctors."

When it comes to mechanoid maintenance, John Hall of Hall Enterprises in Pittsburgh, thinks he's got a head start. Although few robots exist in his part of the country, Hall is sure they will proliferate and will need maintenance. "When a robot malfunctions," he says, "the cost is enormous. It can stop your whole system. Preventive maintenance is going to be increasingly important—we anticipate problems with mechanical wear, wiring, dirt, and smoke. In chemical plants there's corrosion. In painting operations, paint globulars. In welding, there's smoke, dirt, and oil. The price for breakdown is so high you can afford to spend some portion of it as preventive medicine and beat the cost."

In the long run, the robots that will take over the world will probably not be anything like the tin men we see in the movies. They may not even look much like R2D2. They'll probably be much like us—but better. Grossman on the future of robots: "I think we're fighting an uphill battle in trying to make computers control robot limbs. I think there's another potential solution. The molecular biologists can find ways of manipulating genes. And they could make biological machines that can do the same thing. In the long run I'd put my money on them, if ethical concerns don't prevent that line of research."

At the Center For Adaptive Systems at Boston University, a group directed by mathematician and interdisciplinary scientist Stephen Grossberg is studying the neuromechanisms of learning, perception, and motor control—for robotics. "In the

"Earth loses gravitational pull... details at eleven."

course of brain research we are led to mathematical models of a number of neural processes," Grossberg says. "Our goal is to use the designs that come out of our direct study of behavior to suggest designs for new types of machines."

Grossberg thinks a natural counterpoint to computer-based intelligent machines is to use the brain's extraordinary learning properties as a model. One reason there has been such relatively slow progress in questions of machine learning, he tells us, is that the architecture of the brain is so different from that of computers. Since the brain is organized primarily for adaptation to uncertainty, a new artificial intelligence based on the brain's self-organization, its adaptive nature, should be a major motif of artificial intelligence, "not a peripheral theme you tack on later, as people in AI have done with great ingenuity." But not *enough* ingenuity.

Grossberg gives us an example of self-organization: "How do the eyes react to motions of the head when you're running? Your head is bobbing along—it has nothing to do with your planned motion. How do the eyes know to move in compensatory motion? God doesn't go in and say, 'Eyes, I'm going to tell you all there is to know about the parameters of the head, because they are always changing.' No one ever tells us what the rules of the environment are. In fact, there are probably no rules at all in the traditional sense of that word. And this is the critical dilemma for machine intelligence."

As often, it's a dilemma that won't be resolved without more funding. More money goes into funding research in conventional AI, because the computer companies behind it hope for the big payoff in applications. "These people don't study the brain and its structure," Grossberg points out. "And yet the study of the brain could lead to new architecture, new computers, new machines, new generations of machines in which the goal is not to mimic a computer. So much is known about these future machines that it is very clear to me they will be built."

The quality of excitement Grossberg feels is common among robotic scientists. "I don't think any of it's easy," says MIT's Michael Brady. "There are thousands of wonderful problems, and every time we're arrogant enough to believe we've solved one, what we've really done is created three more. And anyone who has tried to do anything as mundane as get a robot to wave its arm around, a TV camera to see, or a computer to understand a natural language will be filled with awe at the effortless behavior of an average three-year-old child. In working on these automatons, researchers are really discovering everything about the human being."

There are wonderful stories to be written on every level about the nature of robotics," Grossberg says. "After all, if you take it from the highest point of view, we're talking about self-knowledge."

GENE FIXERS

BY TABITHA M. POWLEDGE

Creating huge mice, fixing fly embryos—each step takes us closer to redesigning man

PHOTOGRAPH BY CLAUDE EDELMANN

Like so many reports of genetic research these days this item was big enough to share the network newscasts last fall with the economy the Middle East and the fate of the MX missile Researchers had transplanted genes governing rat growth into mice, and the mice grew bigger than normal in one case, almost twice as big The report followed by only a few weeks the disclosure that, for the first time, scientists had cured a hereditary disorder by transferring normal genetic material into defective fruit fly embryos

Such dramatic achievements are rapidly revealing the secrets of how genes work Some researchers are looking toward the social and economic benefits from say genetically engineering cattle to produce more meat and milk And today s advances bring medicine closer to curing hereditary illness in humans instead of merely treating its symptoms as physicians now are restricted to doing

But with each advance, we may be drifting inevitably toward a development that unnerves most of us—and terrifies many of us the genetic engineering of human beings Neither society nor the scientists themselves have yet faced up to this alarming but very real possibility

Just how close are these miracles? Scientists quite reasonably point out that human genetic engineering still faces immense technical obstacles Getting a new gene into a cell is just the first of many giant steps that are required Like NASA engineers sending a space probe to another planet researchers must not only deliver a gene to their target but then turn it on and get it to work properly

It was just these problems that thwarted the controversial work of UCLA's Dr Martin Cline (See "Spare Genes" by Yvonne Baskin March 1982) In July 1980, working in Italy and Israel he tinkered with the bone marrow of two young women suffering from thalassemia, a fatal defect in hemoglobin production The idea was to give a few of their marrow cells normal hemoglobin genes in hopes that the repaired cells would multiply and cure the inborn defect It does not appear to have worked

When the foreign experiments came to light the following autumn, Cline was asked to resign his post as head of his division The following year the National Institutes of Health stripped him of two federal grants—he had four—worth more than $190,000 The unprecedented punishment was a stern warning to researchers to move slowly in testing gene therapy on people

Unlike space scientists, geneticists have several ways to get their probes to their destinations. Cline s approach is sadly limited, because it can apply only to tissues whose cells like those of bone marrow continue to divide throughout life so that the genetically engineered cells can eventually replace the natural defective ones Many organs produce cells only intermittently or like the brain stop altogether once they are fully developed For defects in these organs, other methods are needed

One hope is to insert the desired gene into a virus that would infect the afflicted tissue and use the virus to get the gene to its target—cells with defective genes Scientists call this viral transduction

Among researchers pursuing this blue-sky scheme is C. Thomas Caskey, professor of medicine and biochemistry at Baylor College of Medicine. He'd like to develop a genetic cure for Lesch-Nyhan disease, a ghastly genetic disorder of the central nervous system Lesch Nyhan children compulsively chew their lips and fingers and otherwise mutilate themselves despite the pain these behaviors cause

The disease results from lack of a brain enzyme with the mouth-filling name of hypoxanthine-guanine phosphoribosyl transferase usually known as HPRT But figuring out a way to use a virus to transfer the HPRT gene into the brain is Caskey acknowledges a pretty tough problem A few viruses do enter the brain but what they do there is devastating Among the candidate viruses are the encephalitis and Coxsackie viruses They cause severe inflammation brain damage, and often death

"If scientists in Europe succeed in an area so exciting and Nobel-worthy, the halls of Congress will ring with cries to close the genetic-engineering gap."

"The problem," as Caskey sees it, "is to engineer a virus so that it will be defective that is will not cause disease, yet will carry the gene into a certain tissue and reproduce it just as disease-causing viruses reproduce their own genes This is a formidable task but not insurmountable."

Perhaps not, but all forms of gene therapy now being explored present problems that will keep them from being widely used "People have gotten the impression that this work is going to lead to miraculous cures Caskey says but it is really going to be applicable only to a small category of patients with rare diseases."

The trouble is that the gene therapies now under development can work only with inherited diseases limited to a single tissue There are relatively few of them Most genetic disorders have far wider effects Cystic fibrosis for example affects the lungs intestinal tract pancreas and sex organs So far, there is no way to deliver a "good" gene to all these tissues at once

Other defects present even more difficult problems Down's syndrome, the most common cause of severe mental retardation, is genetic, but it is not caused by a single gene Instead Down s patients carry an entire extra chromosome a package of DNA comprising several thousand genes No one has been able to devise a way to remove that extra chromosome from every cell in a child s body or to undo the damage it wreaks in the brain

Nor will gene therapy avert such disorders as diabetes heart disease and high blood pressure These are all produced in large part by environmental factors but they develop most often in people genetically predisposed to them These conditions too probably involve more than one gene medical geneticists believe

Getting foreign genetic material into a complex organism is no easy task Most scientists have simply injected the new genes into a fertilized egg through a glass needle finer than a hair They call this technique microinjection The process is traumatic and many of the eggs die But some survive and when transferred into the uterus of a host mother they can live out lives that appear otherwise normal

The first success of this kind was reported by three Yale scientists who were able to identify foreign genes in one, or perhaps two, of 150 newborn mice grown from microinjected eggs Of crucial importance for the future of embryo genetic engineering those mice passed the gene along to their children and grandchildren

But it is not enough simply to get the genes into the animal Once there they must behave normally and this involves two more problems One scientists call gene expression a gene "expresses" itself by making the protein it is supposed to make The other problem is gene regulation, a gene must not only make the right protein, but turn it out at the right place and time, and in the right amount

If putting a foreign gene into an embryonic mouse is no easy task, getting the gene to express itself is far more challenging Unlike NASA engineers geneticists have found it difficult to find the biological equivalent for radioing a command to their cellular probes Since the Yale announcement a number of research groups have reported successful gene insertion, and even inheritance But only three have claimed that the foreign genes in their engineered rodents were expressed

The first report of success came in 1981 from the laboratory of Beatrice Mintz at the Institute for Cancer Research Fox Chase Cancer Center in Philadelphia Her group's foreign gene was manufactured from two snippets of natural DNA One part was a human gene that makes a section of hemoglobin the oxygen-carrying protein of red blood cells The rest came from the herpes simplex virus where it makes an enzyme called thymidine kinase (*tk*) Scientists use the herpes *tk* gene for insertion experiments because it is a useful

marker If they can find *tk* in the cells after the test they know the gene has arrived safely at its designated target

When Mintz's group examined mouse fetuses grown from the eggs they had injected they discovered that at least five—15 percent—contained copies of the artificial gene More important, in at least one fetus they found *tk*, proof that the viral gene was functioning in the mouse's cells

Since then they have identified foreign DNA in adult mice grown from microinjected embryos they have even found it in offspring of those mice, showing that the gene can be inherited But there was no evidence that the gene was expressed in the second generation

Another Philadelphia research team has taken genetic engineering in mice much further In their early experiments the *tk* gene expressed itself both in their microinjected mice and in the first generation's children and grandchildren This exciting first was the result of a collaboration between Richard D Palmiter of the Howard Hughes Medical Institute Laboratory at the University of Washington and Ralph L Brinster and Howard Y Chen of the School of Veterinary Medicine at the University of Pennsylvania It stunned their peers

Their method is intricate and clever and it holds great promise for future triumphs Palmiter also started with the herpes *tk* gene the rest of the team's composite came from a mouse where it promotes and regulates production of an interesting protein known as metallothionein Found in all animal cells, metallothionein probably helps the body to dispose of heavy metals In fact its production is triggered by exposure to such metals as cadmium and zinc

If they could get such a gene into a mouse embryo, the scientists reasoned they could give the mice a dose of cadmium With luck the metal might trick the metallothionein portion of the combined gene into turning on the *tk* section

It worked The group reported last June that ten of the mice (15 percent) grown from microinjected embryos carried the two-part gene Seven made high levels of *tk* in their liver cells after exposure to cadmium What amazed other biologists however was that six of the original seven went on to reproduce and some of their children also made *tk* Two of those children also passed along the active gene to a third generation The bad news was that all the mice that made the herpes enzyme made it in varying unpredictable amounts

Palmiter and Brinster then joined forces with San Diego researchers from the University of California and the Salk Institute and dramatically topped even that achievement This time they hooked the metallothionein gene to mammalian DNA a gene for constructing the hormone that governs growth in rats

Twenty-one mice developed from eggs injected with the fusion gene (the name Palmiter gives to the bits of DNA he links together) Seven of the mice were found to carry the gene After the mice were weaned zinc was added to their diet, apparently triggering the metallothionein gene In turn the metal-sensitive gene called the rat genes into action They began to churn out growth hormone Six of the seven mice grew significantly larger than their littermates One grew almost twice as large as normal Furthermore one of the genetically engineered mice produced 19 offspring ten of which inherited the fusion gene They became second generation mouse giants

The researchers see several practical uses for their work Gigantism in people is a genetic disease that results from an excess of growth hormone the mice might provide an animal model of the malady making it possible to develop ways to treat or cure it The scientists also suggest that it may be possible to "farm" animals getting them to produce large quantities of valuable proteins For example human growth hormone is medically useful but reliable supplies are hard to find The blood of the supermice contained up to 800 times the normal amount of growth hormone

Most important though, the researchers think they may have found a surefire way to stimulate rapid growth of commercially valuable animals "Cattle pigs, sheep, and even chickens may soon grow bigger and faster than today's livestock They may metabolize their food more efficiently, saving money on feed They could produce more meat Cows might yield more milk as well All this would be accomplished simply by adding zinc to the drinking water of genetically engineered animals

Brinster speculates that eventually genes from the immune system might be used to help animals resist disease "We don't know much about this now," he concedes "but we're moving ahead In three to five years we'll know more about the genes involved in disease It's possible an animal could develop its own immunity"

With all this flashy success it is easy to forget that the genetic engineers really don't have a handle on gene expression or regulation yet Genetically engineered mice and their offspring may possess a foreign gene and even produce the substance it dictates, but they still don't produce it in any orderly predictable way The pituitary gland normally makes the body's growth hormone In the mouse experiments the *liver*, and perhaps other tissues as well, poured it out "We are still a long way from controlling the gene," Brinster admits

In fruit fly embryos by contrast scientists at the Carnegie Institution in Baltimore have been much more successful Their work is based on so-called "jumping genes," or transposons—pieces of DNA that move around within the chromosome and even hop from one chromosome to another Geneticist Barbara McClintock, of the Carnegie Institution, discovered transposons in corn more than 30 years ago but the idea sounded so bizarre that few

of her colleagues believed it. Today some scientists suspect that all life forms carry jumping genes, though the function of transposons has not yet been settled.

Fruit flies possess transposons, and Carnegie scientists Gerald M. Rubin and Allan C. Spradling have been able to use them to ferry genes into fruit-fly embryos. For the first time, researchers achieved stable gene expression in the process curing a genetic defect.

Fruit flies normally have brick-red eyes, courtesy of a gene scientists have dubbed *rosy*. This gene produces an enzyme called xanthine dehydrogenase; fruit flies without it have boring brown eyes. Using standard gene-splicing techniques, Rubin and Spradling insinuated the *rosy* gene into a fruit-fly transposon and microinjected the piggyback DNA into embryos lacking the gene. For technical reasons the piggyback DNA had no effect on the embryos themselves. They grew up to be brown-eyed flies. But the *rosy* gene did fit itself into the eggs and sperm of up to half of those flies, and their children grew up with the flashing red eyes of true-blue fruit flies.

In the world of biology, where startling revelations have come along daily for several years, Rubin and Spradling have created a mighty flap. In addition to achieving the first real cure for a genetic defect, they brought scientists a giant step closer to adequate control of gene expression.

Of course fruit flies are not people; they are not even mice. But Rubin and Spradling are confident that transposons will eventually make it possible to modify the genes of many plants and animals. And the limits? No one is willing to say that there are any presently in view.

These successes in engineering other species force us to wonder about the genetic manipulation of *Homo sapiens*. For example, since today's methods of gene therapy are so limited, should we abandon the idea of repairing specific tissues genetically and work only with embryos early in their development? This would cure any genetic disease in them throughout the body. The technique could be used in any condition where a "good" gene could be identified and inserted. Since the good gene would be passed on in the eggs or sperm, it would also cure those ills in all the patient's descendants.

Scientists insist that genetic engineering of human embryos will never happen. Let's examine their arguments.

The technical barriers are immense.

Yes, but most will yield in time. The recent experiments with mice and fruit flies have begun to unravel even the knotty problem of controlling gene expression. So far there is no reason to doubt that these methods can be applied to our own species. In short, we can be reasonably sure that technical barriers will crumble, and in genetic engineering they have tended to crumble extremely quickly.

The failure rate is too high and society would never tolerate the destruction of fertilized human eggs in such numbers, even at the one-cell stage.

True, not many fertilized eggs survive microinjection and develop into normal animals. But how important that is depends on the society. In the United States right now, destruction of fertilized eggs would certainly provoke howls of protest from the right-to-life lobby. But in the rest of the world this group's power is virtually nil. There are plenty of labs in western Europe capable of embryo engineering. Some of the work on mice has been done there. If scientists in Europe or anywhere else succeed in an area so exciting and Nobel-worthy, the halls of Congress will ring with cries to close the genetic-engineering gap—especially when American scientists start threatening to fake their test tubes elsewhere. The clamor will drown out the right-to-life contingent.

There are simpler ways to deal with burdensome genetic defects.

This is the most cogent argument against embryo engineering. Current medical techniques will remain the first line of defense against disorders caused by single genes. And when scientists learn to read the genes in reproductive cells removed from the body, rather than performing gene therapy, it will make more sense to discard defective embryos and implant a good one in the mother-to-be.

> "It is hard to deny that healing such children is better than ending their lives. Embryos will be lost in early research, but this can be seen as a lifesaving sacrifice."

Yet a few would-be parents have no chance at all of producing a normal child, and their numbers are growing as medicine learns to treat ills that were once crippling or fatal. Take for example phenylketonuria (PKU), a genetic disease in which the body fails to break down phenylalanine, an amino acid found in meat and milk. PKU patients were once condemned to severe mental retardation, but today the condition can be detected shortly after birth. PKU sufferers can be placed on diets low in phenylalanine for a few years and after that live essentially normal lives.

In the United States, screening for PKU has been routine, often by law, for the past 20 years. So a growing number of otherwise healthy adults have PKU. When two of these people meet, marry, and start a family, which is bound to happen eventually, all their children will also be afflicted with the disease.

They can, of course, adopt children instead. Or they can have children and put them on the special diet. But if some genetic engineer finds a way to transfer a working anti-PKU gene into an embryo, he will be sorely tempted to cure the couple's fertilized egg. And what couple would refuse the chance to have a child of their own who was free of the disease?

Treatment for sickle-cell anemia, thalassemia, and cystic fibrosis has also improved so that some patients can consider parenthood. Here, too, it is inevitable that occasionally two people with the same disability will want children. Given better medical care, other diseases will join the list, and marriages like these will become more common. So will sick kids.

The humane wish to give such couples normal children—and the woeful limits of today's gene therapy—will finally open the Pandora's box of embryo tampering. Two other arguments will help override objections to human genetic engineering.

Curing an affected fetus is preferable to ending its existence by abortion.

Where there is no good treatment for a genetic disorder, prenatal diagnosis and abortion are now our only defense. An example is Tay-Sachs disease. Found mostly among Jews with eastern European roots, the condition is an implacable destroyer of infants. It is hard to deny that healing such children is better than ending their lives. Embryos will be lost in the early experiments, but this can be seen as a lifesaving sacrifice in the long run.

Embryo engineering will prevent disease in future generations.

Since the person who grows from a genetically repaired embryo will pass along the "good" gene to all descendants, their progeny will be cured as well. Who is curmudgeon enough to reject such a benefit?

Once we have bought these arguments, though, we may buy others. If cattle are given the ability to resist disease, will we deny the same ability to people? And why should we confine genetic engineering to disease? If zinc can be used to regulate bovine growth hormone, why not human hormones as well? Sex hormones, say. Pop ten milligrams of zinc gluconate for an instant aphrodisiac.

Perhaps that is only a fantasy. So perhaps is the idea of being able to alter intelligence and other complex, poorly understood traits. But we should remember that genetic engineering has, from the first, been unpredictable.

We should also understand that because we want to heal hereditary illness, we are slipping toward the genetic engineering of human beings almost without realizing it. Genetic engineering will not be forced upon us, as a few social forecasters have led us to believe, by a new Hitler wishing a mindlessly obedient populace. We will seek it out, applaud its humane goals, and espouse it eagerly. ∞

Robots may bring on a new Victorian Age, complete with wealth, leisure, and personal goods delivered by gibbonlike automatons, says the high prophet of artificial intelligence

INTERVIEW

JOHN McCARTHY

John McCarthy, the fifty-five-year-old director of Stanford University's Artificial Intelligence Laboratory is, in a sense, the father of all close relations between humans and computers. It was McCarthy who, while organizing the first conference on the subject at Dartmouth in the summer of 1956, invented the term "artificial intelligence" to describe the then-emerging field. McCarthy also has the distinction of having founded two of the world's three great laboratories of artificial intelligence: the MIT laboratory in 1957 with Marvin Minsky, and the Stanford laboratory, in 1963. (The third is part of Carnegie-Mellon University.)

While at MIT, McCarthy also invented a kind of computer time sharing called interactive computing, in which a central computer was connected to multiple terminals—the first practical one-to-one relation between a computer and its many users, each of whom could feel he had the machine all to himself. In 1958, he also created the computer language LISP (List Processing Language)—the successor to the mathematical language of FORTRAN—in which most "intelligent" computer programs have been written. He founded a subbranch of mathematics called "the semantics of computation," and solved its first significant problems, such as how to test certain classes of complicated computer programs to see if they were correct, and how to "crunch down," or simplify, the number of steps involved in certain very complex computer operations. Over the past twenty-five years McCarthy has created a continuing succession of ideas that have been turned into computer hardware or programs.

Last summer, at the annual meeting of the National Conference on Artificial Intelligence, McCarthy and Minsky—the two founders of the field—confronted one another publicly, as they have privately over the years, on the real problem of artificial intelligence.

PHOTOGRAPH BY CHUCK O'REAR

how to give machines common sense. There now exist industrial robots with limited abilities, and so-called "expert systems"—computer programs that can mimic the analytical procedures a doctor performs in diagnosing disease, or that a geologist follows in deciding where to dig to strike a mineral. And an endless variety of "smart" devices, such as self-regulating thermostats and automobile rotor sensors, are now being developed that are based on the decision-trees that can be built into microchips. But all of this, says McCarthy, doesn't address the real issue. These systems are useful and clever, but are no real match for human intelligence. What is simple for a computer is difficult for human beings: chess, mathematics, and expert knowledge. And what is simple for human beings is difficult for computers: common-sense thinking.

To illustrate the problem, Minsky and McCarthy offer the statement, "Birds can fly." It is clear that this statement is usually true—but not in all circumstances. The ostrich and the penguin can't fly. Dead birds can't fly. Birds held down by their feet can't fly. These exceptions seem obvious to humans, but to a computer that has been given 'Birds can fly' as a statement of fact, such exceptions can wreak havoc. The study of artificial intelligence has stalled at this juncture.

The problem, according to McCarthy—and it is at the heart of all questions of intelligence—is one of organization. A machine might be stuffed with the same billions of bits of information contained in a human brain. But recalling any one bit from memory—an operation that the brain can usually perform in milliseconds—cannot be done simply by sitting through a heap. If the job were done that way, it would take days for a human to move from the living room to the bathroom, because each bit of information—*What is a bathroom? Is there one nearby? How can I transport my anxious self there?*—would require a full search of the brain's contents. So the challenge is to organize huge amounts of knowledge in a way that permits humans, or computers, to retrieve it at will—to mix and match pieces of knowledge and to establish permanent links between them so one will bring up the other.

McCarthy offers one approach to the problem, Minsky another. In Minsky's scheme, information stored by the computer or brain is handled in "frames." A "frame" is something like a context or dominant idea in an argument—a concept ("bird") with many other related concepts or bits of information ("feather," "flight," "egg-laying") attached to it in slots, or "subframes." Each frame, of course, is connected. Calling up one may lead to calling up another, and so on. Thus in Minsky's frames, knowledge is linked in chains of association, but is always dominated by the frame.

McCarthy's approach is to create a new form of logic called nonmonotonic logic, that can tolerate ambiguity without losing the rigorousness of mathematical reasoning. In mathematical logic it is easy to make the statement, "A boat can cross a river." In the real world this may be true, but boats may also leak or be missing oars. In logic these conditions might be accounted for simply by tacking them onto the first statement: "And there must be no leak and there must be oars." But there are bound to be additional unanticipated disasters awaiting boaters. McCarthy's solution is to say: "The boat may be used as a vehicle for crossing a body of water, *unless something prevents it.*" In ordinary mathematical logic this would not suffice, because every exception must be laid out item by item. But McCarthy's approach provides a way of going ahead with incomplete information. It, for example, the computer hits the phrase, "unless something prevents it," and finds nothing entered beneath that phrase—no leaks, no lost oars—it will continue on. If, on the other hand, it encounters "leak in the boat," it will turn down a new path dealing with leaks, water, and repair. Using such a chain of interrelated logical statements it is not necessary—as it is in Minsky's system—for one concept to dominate.

> *"What I would like is to extend the power of the individual through these automatic means so that one man could build a car or house all by himself."*

McCarthy admits that this is probably not how the human brain works, "but this is AI, so we don't care if it is psychologically real." Minsky's frames come no closer to modeling the power and flexibility of human thought. And neither method has proved practical so far in building intelligent programs. But then, neither man believes that machines will achieve anything approaching human intelligence any time soon.

Meanwhile, McCarthy allows his thoughts to roam freely. A rather shy man, he possesses an extraordinary ability to concentrate his mind on a single idea—to step wholly into it. "A large part of his creativity," says one colleague, "comes from his ability to focus on one thing. The hazard of that is, everything else gets screwed up."

Born to an Irish Catholic father and a Lithuanian Jewish mother, McCarthy was raised, along with his younger brother Patrick, by parents who abandoned their religions to embrace atheism and Marxism. Thrown out of Cal Tech for refusing to attend physical-education classes, McCarthy was among the last Americans drafted into World War II. After the war he returned to Cal Tech to earn his bachelor's degree, then went on to earn his Ph.D. at Princeton. In 1956 he was offered his first teaching position in the mathematics department at Dartmouth. In 1957 he moved to MIT, and in 1963 accepted an offer to head his own department at Stanford.

A widower and father of two daughters (his second wife Vera died in a climbing accident during the 1980 all-women ascent of Annapurna), McCarthy is a bit awkward socially, sometimes ignoring the usual conventions. But though he may appear absentminded and distant, his interior life seems to be one continuous stream of ideas—not only in the fields of mathematics and computing, but also in politics, literature, music, or plumbing. An avid reader of science fiction, he is also the author of a number of stories that, thus far, remain unpublished. When his home thermostat malfunctioned some years ago, causing the temperature in some rooms of his house to climb above 80°F, McCarthy was inspired to write an unpublished philosophical treatise—available to anyone who cares to call it up on Stanford's computerized "memo system"—on the subject of whether it is proper to say that thermostats "believe" and can have "mistaken beliefs." He once had to struggle with moving a piano up a flight of stairs. Soon afterward he was deep into the problem of transporting heavy objects over difficult and uneven terrain. His answer: a cleverly designed six-legged mechanism that could carry a piano up and down stairs.

In this interview, conducted at McCarthy's Stanford home and in a local restaurant by Philip J. Hilts, national staff writer for *The Washington Post* and author of *Scientific Temperaments: Three Lives in Contemporary Science*, McCarthy leaps from mundane questions to fantastical proposals, calculations, and other oddities. This is John McCarthy. His mind does not remain on factual, earthly matters for more than a few seconds before it is again taking off into another fanciful possibility—some of which he has thought about a great deal. What follows may not be the conventional interview, but then, McCarthy is not the conventional scientist.

Omni: I want to ask you first of all about the robotic arms and eyes coming into use in industry. So far the main application of these things is in the assembly line.

McCarthy: Yes, so far this is the main application of robotics. One of the things that has happened recently is a great proliferation of little devices of different costs; you can buy something for as little as 1 500 dollars that can move its hands around and pick up things—a sort of toy for hobbyists. It's controlled by a microprocessor. I'm not sure what its limitations are. It's not very

strong however and it may not be very reliable If you tried to run it all day it might break down Like almost all robotics in use today it does not have a mind Because of this what we have is very limited

Omni But there has been some progress toward making mechanical arms and robots smarter?

McCarthy There are two directions in which things are advancing force-sensing for the mechanical hands, and specialized systems of vision The original robots had no mechanism for sensing how much force their hands were exerting so the commands were simply commands for specific motions Now that meant most things did not quite fit There had to be sufficient give in the object being picked up to make up for the limitations of the robot arm More recently the arms have been fitted with force sensors so that the servoing, or servomechanism—the program that confrols the arm—actually measures force In other words suppose you want the robot to put a slightly tapered peg in a hole The robot hand would move the peg downward and begin to sense a force on one side of the peg, which would tell the machine it hasn t got the peg quife centered so the hand would move the peg over a little bit

Omni And in the area of vision?

McCarthy There are several things being done One is to seek out special cases in which you don t have to solve the whole vision problem—in which the robot doesn t have to see or have full recognition of three-dimensional objects as a human does There are many problems that can be solved by using plane views so you have only a two-dimensional problem to worry about, rather than a three-dimensional one

Omni Give me an example

McCarthy Suppose you have flat parts moving on a belt A part may be in one position or it may be rotated but the robot can use a template to identify it and its orientation You can have a fixed camera up above looking straight down, and the program can rotate a template until it matches the shape of the object in its current orientation

Another specialized vision problem is flight simulation It s fairly complicated to represent the moving landscape ahead of and under an airplane chiefly because parts of objects are always hidden from any particular view of a scene—the far side of hills and so on Well there are now programs for simulating the continually changing views and conditions of flight

Omni How much specialized programming has found its way into industry?

McCarthy These things aren t in industry except for the computer simulation being used in movies and so on In general I think people are far less ambitious about getting vision and manipulation into industry than they were, say fifteen years ago

Omni Really? Why?

McCarthy Well I'm not sure Mainly, I think because the problems are very hard and as people have begun to work on the very hard problems of vision and manipulation they ve identified easier subproblems In the beginning people said, "I want my robot to do what a human does" But part of the progress has consisted of identifying easier subproblems the solutions to which are nonetheless useful in themselves Specific factory-automation devices are one set of easier things that don't go a long way toward solving the real problem of how vision works Another system that has been worked on here at Stanford is one that can look at an aerial photograph of San Francisco Airport and pick out the airplanes—distinguish them from buildings and vehicles and see airplanes that are partly obscured or hidden

Omni This is from an aerial photograph? It could pick out certain objects, such as missiles on the ground?

McCarthy Yes it could The Defense Department is paying for its development But it s also a good scientific problem—being able to take a whole scene and find all the similar objects in it

Omni What s the chief problem to overcome here?

McCarthy I don't know It always seems to me we ought to make faster progress in robotics than we do When I first started on robotics in 1965 or so we sfated in our first proposal that we would get a robot to assemble a Heathkit [a build-it-yourself electronics kit] It s still not entirely clear to me why that proved impossible

Omni You actually got a kit and tried it?

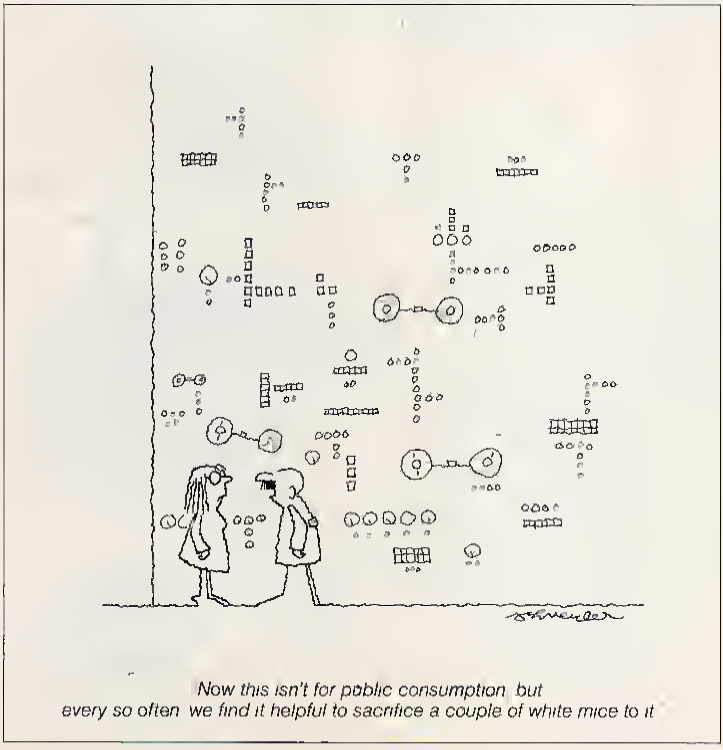
McCarthy No The robot arms were never flexible enough to do the mechanical motions nor did we have programs to control them The old-fashioned Heathkits involved threading, bending cutting and soldering wires It required considerable dexterity and sophistication to know where and how much force to apply I don't think we were even close to if

Omni Are we getting closer now?

McCarthy No I think everyone's working on the easier problems In my view what everyone wants eventually is not only a robot fhat will take its place in the assembly line but a "universal manufacturing machine" This would be more like one robot that could make a whole TV set a whole camera or a whole car The robot might have several arms and a collecfion of tools But it would be interesting if you could sell the thing if you could go to your neighborhood assembly shop and say "Well, I'd like that TV from the cafalog but with this additional feature" The TV would be made by one machine So you could retain the low cost of mass production but still get individuality and custom design as if it were handmade What I would like with these automated means is to extend the power of an individual so that one man could build a house or car for himself

Omni How would you do fhat?

McCarfhy Well rent a gang of robots as it were As it is now, whenever you see a



Now this isn't for public consumption but every so often we find it helpful to sacrifice a couple of white mice to it

construction site none of the cranes and bulldozers bear the name of the company that s doing the construction They bear the name of the company from which the equipment is rented So first you d design the house or car and the design would go through a lot of computer testing you d simulate the construction before you began and the computer would tell you exactly what equipment to rent You d rent the robot equipment and it would build the house or car

Let s not imagine this is something the average person would do The Rockefeller Foundation had a slogan around 1910 largely forgotten now which was "Make the peaks higher" It meant take the best existing research institutions and make them still better—the direct opposite of equality And from the point of view of increasing what a particular individual could do versus what everybody could do one would also like to make the peaks higher And what can be done by one person or a small group of people has increased as technology has advanced I believe robotics can advance that a lot more

Omni I hear many inventors complaining that they have no way of approaching corporations—that they d like to do something but they can t I guess being able to rent robots would help

McCarthy Yes right But of course half of the inventors are crackpots As for the other half—even the guys who aren t crackpots—90 percent of their inventions aren t going to make it

I had an experience trying to market an idea In fact I m still convinced the idea is practical

Omni Can you tell me what it is?

McCarthy I suppose so Since I can t make money out of it I ve recently been trying to give it away It s a computer mail terminal You could buy this thing from a department store and then you could type on it MAIL THIS MESSAGE TO SO-AND-SO It would be connected to the telephone system and one computer would call up another terminal and deliver the message It seems to me that inventing the thing itself was easy enough but to persuade some company to make it was harder My partner and I had a lot of contacts and interviews with prominent companies so we didn t have any problems getting attention Nevertheless not one of them decided to produce the terminal

Omni Would it be cheaper than a home computer?

McCarthy It would be more expensive than some home computers and less expensive than others Something like the Sinclair couldn t do it It wouldn t be enough computer It doesn t have enough storage to store messages or enough display to permit you to conveniently compose messages and so forth So it would be a specialized home computer

Now programs for that purpose and the necessary equipment to attach to the phone system are probably being developed for

home computers But no universal convention exists that would permit any home computer anywhere in the world to send messages to any other home computer anywhere in the world I think there's a good chance IBM will develop one At least I tried to give them the idea

Omni What do you think will ultimately be made possible through robotics, and what forms will robots eventually take?

McCarthy It seems to me that what can be done and what will be done don't exactly coincide There's an enormous variety of things that *can* be done The extreme example would be machines built along the lines of the science-fiction-story robots

Omni Humanlike things that walk around?

McCarthy Yeah

Omni Is that practical? I mean is there any use for something like that?

McCarthy In some sense science fiction's portrayal of robots involves a kind of sociological imagination During the Twenties and Thirties robots were depicted in films and stories as an enemy tribe that attempted to conquer the world and our hero wiped them out By the Fifties robots had become an oppressed minority and our hero sympathized with them But those ideas had little to do with human needs They had to do with literary needs Now, Isaac Asimov, who is the most popular writer to write about robots has formulated these laws of robotics in which he almost intentionally confuses natural laws—laws of motion—with legislated laws He implies that his legislated laws—that a robot should not harm a human being for example—are in some sense natural laws of robotics And then he writes these almost Talmudic stories in which the robots argue about whether something is or is not permissible according to the law Well that of course is also literary

Now what shall we want? One thing that seems reasonably clear to me is that making robots of human size and shape is the least likely Rather more practical would be a robot that is much smaller or much bigger than a human and could do things humans cannot do because of their size or shape It would seem to me the first winners would be robots quite different from a human There is, however one advantage to robots of human shape and size They could use facilities that were designed for human beings

One of my ideas along these lines that is ultimately possible—and I've been thinking about it for many years—is the automatic-delivery system I'd like to be able to turn to my computer terminal, type into it that I want a half-gallon of milk or a new gadget and, twenty minutes later the milk or gadget would appear automatically

Omni By what system?

McCarthy The first system one thinks of as a child is, of course, little trains that run along in tunnels under the streets and so forth What's wrong with that idea as it stands? Well the little trains are expensive and not very fast They can't carry very big objects and they require an expensive redesign of the whole city My current scheme is as follows There's a nineteenth-century version and a twentieth-century version or eco version The nineteenth-century version involves cables strung on poles like the cables at ski resorts The carriers are two-armed robots, except that they've got one arm like a gibbon and they hang on to the cable with one arm They can switch cables by grabbing another one

Omni And these things somehow carry the objects being moved, and then swing like monkeys across these cables?

McCarthy Right Now the other thing that they can do is climb the outside of a building on handholds that have been built into the building They deliver things to a box, maybe the size and shape of an air conditioner, which is built into an outside wall And after a while you hear these clanking noises and what you've ordered appears in this box

Now in the eco-version, which is much more expensive these things are in tunnels under the streets, so you don't have them clanking around overhead But the idea that they would either come down from their poles or come out from underground and climb outside the building strikes me as essential in order to make them compatible with present buildings

"Making robots of human size and shape is least likely. More practical would be a robot much bigger or smaller than humans. Then the robot could do things humans can't do."

Omni We could have a little tube running up the side of the building

McCarthy Yes but remember, not everybody would subscribe to the service at first Not many of us are of the generation that remembers the installation of electricity Just consider what an enormous amount of work that was You look at old buildings and say "How did they ever install electricity in that house?" They had to tear up bits of the walls to run the wires through The other possibility—or the other extreme possibility is a walking robot that after it comes down from the cables or up from underground simply walks over and knocks on your door In some sense that would be more flexible Something could be delivered to someone who wasn't a subscriber

What I envision actually with regard to robots, are some fairly large social changes that would bring about a return to the Victorian Age in a certain respect If you had this robot to work twenty-four hours a day you would think of more and more things for it to do This would bring about an elaboration in standards of decoration, style and service For example what you would regard as an acceptably set dinner table would correspond to the standards of the fanciest restaurant or to the old-fashioned nineteenth-century standards of somebody who was very rich Standards would conform to what we imagined to be those of the British aristocracy because they had servants People ask, "Well what will happen when we have robots?" And there is a very good example of historical parallel Namely, what did the rich do when they had lots of servants?

Omni How many years must we wait?

McCarthy I don't know It's not a development question It requires some fundamental conceptual advances on the order of the discovery of DNA's structure Maybe once these advances are made progress will be straightforward

Omni Would robot intelligence and human intelligence be alike? Humans are motivated by anger jealousy ambition sensitivity And in literature robots are portrayed as possessing these same motivations

McCarthy I don't think it would be to our advantage to make robots whose moods are affected by their chemical state In fact, it would be a greater chore to simulate the chemical state And it would probably also be a mistake to make robots in which subgoals would interfere with the main goals For example according to Freudian theory we develop our ideas of morality in order to please our parents But then eventually we will pursue these concepts even in opposition to our parents The general human instinct to assert independence is something that would require some effort to build into robots It doesn't seem to our advantage to make that effort

Omni What about the possible disruption—the unemployment that could be caused by robots?

McCarthy Well there are two questions that have to be answered One has to do with superrobots In other words what will happen when we have robots that are as intelligent as people which is a long way off The other has to do with simple automation which is similar to the advances in productivity that have already occurred

The United States and other countries have gone through various economic cycles of unemployment and full employment These countries have also gone through various periods of rapid or slow technological development No one has ever attempted to correlate these things But I think what would be observed is that there is no correlation—that periods of high unemployment are not especially correlated with periods of rapid technological advance In fact on the average, more advanced countries have somewhat lower unemployment than do the less technologically

CONTINUED ON PAGE 122

FICTION

THE END OF THE WORLD NEWS

BY ANTHONY BURGESS

In Part One, Brodie and Willett left New York City, which was devastated by tides roused by the planet Lynx. Meanwhile, scientists in a small Kansas town work feverishly to complete a spaceship designed to save the cream of American intellects from the impending collision with the wayward planet. There's dissatisfaction brewing among the scientists, outsiders (including Brodie and Willett) are converging on the project center, and Lynx temporarily becomes a new heavenly body around which Earth will orbit until the two planets collide.

"As they used to say in vaudeville," Willett grunted, "*this must be the place*." He made certain adjustments to the controls that kept the thing hovering in the hostile winds—hostile to one another as well as to their craft. Val could still not get over his surprise that Willett, actor, eater, swiller, and praiser of the past,

This is the second part of a two part excerpt

PAINTING BY
JEAN-MARIE POUMEYROL

should be so skillful with a helicopter.

They had picked up this particular helicopter near Sedalia, Missouri. Land transport had by now been thoroughly obstructed by broken roads, folds of upturned earth, perpetual jolting tremors. They had been astonished, near Sedalia, to see in broad midday a patch of air wholly taken up by helicopters engaged in crashing into each other in individual suicide combat. Madness. Lyncstatic madness. There was a metal notice, twisted, battered, lying on scorched grass, which said HELIBASE 56. Over an excessively amplified loudspeaker system joyful, simple music was being discoursed.

Val and Willett went cautiously closer to the thick net periphery. A tipsy sergeant had welcomed them in to the funeral games. What had apparently begun as a helicopter square dance had turned into a dodgem course. Now it was rank joyful suicide. Could anybody play? Well, said the sergeant. Val and Willett were civilians, not really eligible. On furlough, Willett said, both. Meet Colonel Allnut and Major Catastrophe. No trouble then. And they were zigzaggedly escorted to the helicopter park, bottles of scotch thrust into their hands by a singing corporal. Then they were off and up, not really playing the game.

They put down outside Topeka, Kansas, at a big mess hall that was full of grumbling military.

Val asked about the CAT camp. Nobody knew it. Wait, how about Shorty? Shorty's outfit had broken up.

Shorty had been posted to this clean-up battalion, grousing and even tearful about being cut off from his old buddies and full of unbelievable stories about a moonship and a guy in charge called Boss Cat, in a dump called Sloansville.

Up in the air, Willett said, "You were right you see. Your book probably gave those nonfictitious scientific bastards the idea."

Val woke from unpleasant dreams out of which he was, anyway, lucky to be able to wake. He looked down and saw a great neat square, impeccably right-angled, huts, huts, huts, and in the middle *it*, the thing, the end of the known road, big and squat and beautiful. His heart dropped to his gross muddy worn work boots. "What do we do now?" Willett asked. "Land by it? Open its door? Walk in and take a seat?"

"Wait," said Val with the caution of a science-fiction writer. "We'll wait. Land. Behind that clump of elms there."

The earth hiccupped. Just south of Sloansville an Englishman named Elias Howe addressed a crowd through a loudspeaker. The crowd was about two hundred strong—men, women, children, cripples, ancients, frightened Kansans all of them.

From The End of the World News *by Anthony Burgess. Copyright © 1983 by Liana Burgess. Reprinted by permission of McGraw-Hill Book Company. Published in the United Kingdom by Hutchinson Publishers.*

"You know the truth of it, friends," he said. "The earth," he said prosaically, "has had a long run for its money. It had to be finished off someday, and it's going to end as it began, with capitalists on top and workingmen ground into the dirt beneath. Make no mistake about it, sisters and brothers. At that camp up there, with its electrical wires all around it to keep people out, is a ship that's going off into space, loaded with the wealthy, being served champagne and caviar. And where are they going? you may ask. Well, I'll tell you, friends and comrades. They're not going anywhere except into space up there, far away from that horrible planet and our moon that it stole to bang at us like a big white rock. Well, I'll tell you what's happening tonight, brothers and mothers and dads and sisters. They're not going. The scientists that run it are going to be in the service of the workers, whether they like it or not. If we don't go, nobody goes."

The crowd cheered. A one-eyed man at the front said, "Who shoots first?"

> *"The platoon sergeant, at a nod from his lieutenant, ordered the opening of fire. There was a fine chorus of bangs, a bacon smell, but nobody dropped down dead."*

"Nobody shoots if it can be avoided, friends and comrades. Violence was always the way of the capitalists, they having the money for the weapons. Those of you carrying guns, don't fire till the word's given. Those of you with insulating gloves and cutters, don't be afraid of the hard work of cutting their fences down—an outer one and an inner one, as you'll know. The cutting party goes first." The earth hiccupped, the crowd roared.

Evangelist Calvin Gropius, his son Dashiel, and the strange girl Edwina, who was now very near her time, drove wearily into the town of Sloansville. It was intact but deserted, except for a small coffee shop with the legend JACK JOE & CURLY above. It was lighted by a couple of oil lamps, and a man who could not be Curly because of his baldness or perhaps was Curly because of it was playing checkers calmly with an old man. They did not at first look up when Gropius's party wearily shambled in. The old man finished the game with a leaping and demolishing king, then looked up in toothless triumph. "Got you there, boy."

"You folks come for the big rally? Well nigh on two hundred marching to it. That right, boy?" he said to Jack, Joe, or Curly.

"What's this?" asked Dashiel sharply.

"Big Commie rally. Not seen one of them afore in these parts. No call for communism this part of the world. Up at the camp up the road. This English feller was here talking about the workers and the caplists. I knew what he meant. One of my own boys—young Charlie it was—went that way after he'd been in the army. I ain't got nothing against it deep down, mind."

The earth hiccupped. "Is that what that helicopter was about?" O'Grady asked. "Earlier on, that chopper. Looking at our defenses?"

"No problem up there," Bartlett said. "As long as our magnetized cover holds."

"How far can you trust them with weapons?" O'Grady meant the CAT team himself excluded.

"They'll never get in," Bartlett said. Still he gave O'Grady a Hutchinson hipman, with three ammogiros, and took one for himself. He also wound about his torso a casing of gas bomblets.

And the troops? said O'Grady.

"Johnson's issuing them rifles. Blanks, of course. Can't risk giving them lives."

"But they're supposed to be here to protect us. Aren't they?"

"We protect ourselves," O'Grady.

Illuminated solely by absurdly amplified moonlight, Lynx being temporarily occluded by its stolen satellite, the two of them went to meet the mob, first looking in on the CAT team, now no longer laughing, and telling them to await instructions. There were instructions, for the moment only for Hazard and Vanessa.

The two of them were taken outside and given, respectively, a hipman and a Lescaz pistol. They handled them unhandily, wide-eyed both. "I never thought it would come to this," said Bartlett.

A group was concentrating on cutting at the electrified perimeter, one place only, no wasteful hacking all over. A British lower-class voice came with high-pitched clarity over a loudspeaker. "In the name of the oppressed," it said, "we order you to hand over your spacecraft to the workers. We want no violence. Drop your weapons. Open that gate. Let us in. We come in peace. All we ask is what we want, that being what is the workers' rights." The platoon sergeant, at a nod from his lieutenant, ordered the opening of fire. There was a fine ragged chorus of bangs, a fried-bacon smell, but although the members of the crowd nearest the wire rushed back, sending those tottering and falling, nobody dropped down dead. Lieutenant Johnson looked round curiously at his civilian masters. The sergeant gave the firing order again, and again there was a blind hash of harmless banging. As in rebuke of such kid's play, growling and crashing from all over the horizon, the adult stuff of real killing: hills falling, cities crashing, resounded crisply.

A voice that disdained the use of an electronic prosthesis was now heard, its possessor unseen. "This is Calvin Gropius," it cried. "I demand the right to bear the Word of the Lord into the wide universe that is the Lord's own creation. Open your gates. I demand it. God demands it."

The voice of the workers loud hailed in protest. "The God that's the creation of the bloody capitalists. Open up for the proletariat. Space for the workers."

"Now," I think," said Bartlett, and with a good round aim, he sent a gas bomb flying toward the spot where the cutters had cut away, lighted goldenly by high-voltage sparks. There was a sudden cloud of immense dirtiness and a loud chorus of curses and desperate coughing. The earth hiccupped. The earth went into spasm.

From the same invisible spot as before Gropius resumed: "I demand that the bearer of the Lord's Truth be admitted. *I demand.*" As if to back that up, the nervous spattering of what seemed to be autogun bullets started well behind him. And now some of the workers began to go down, many screaming. Others ran. The loudspeaker cried, "You see what the capitalists are doing, you scientists? Scientists, fellow workers—" There was no more from him, except a howl, a gurgling, a choking, partially amplified.

The Tagliaferros, owners of the Florentine Hotel, were pumping out death into the workers, farmers really, gritting in Sicilian, "Let them die. Why should they live? What right to live do they have, the bastards?"

Behind a shivering oak, stretched out in the warm night asleep, were, for a time, Val and Willett. They had eaten and drunk heartily; they were very weary after their adventures. They did not respond to noise. They had finally learned to sleep through noise. They had had nothing but noise since their journey began. It was almost by chance that Dashiel Gropius dragged Edwina Goya to protection behind that same tree. There were not, in fact, many trees around. "Good God," said Edwina, forgetting her pains, "it can't be. It's Dr Brodie." She shook him. "Dr Brodie, wake up. There's terrible danger."

But it was Willett who woke first, grunting, groaning, smacking, very bleary. He did not know these two, and he quickly grasped the pistol at his belt. The girl was pregnant, he noticed. Jesus, this was no time for getting pregnant.

"Edwina," said Val, now awake. "what the hell are you doing here?" He had seen her last in the departmental library of the university, glooming over a huge variorum edition of John Donne.

"This," said Edwina, "is the end of the world. I presume anybody can join in."

"What a lot of people!" Willett said in wonder, seeing shrieking Kansans running everywhere. "The chopper," he said. "It's safe?" It was not safe, not with maddened scamperers quite likely to take off from the carnage and the end of the world with it. Willett fired a couple of stray shots and saw people stumble, howling, scattering.

Dashiel said, "Gropius is my name. I'd suggest that—"

"You're too young for Gropius." Val frowned, looking puzzled.

"Dashiel Gropius. My father, Calvin Gropius, is over there, demanding entrance in God's name. Look, this lady's near her time, as you can see. There must be doctors inside that place—"

"It's all doctors." Edwina winced, her face clenching on her pain like a fist.

"The only way in," Dashiel said, "would be from the air. I'm assuming you know how to drive that thing—"

Willett said, "Let's get in and up. At least we can get away from that bastard who's spreading death, whoever he is."

"One of the Tagliaferro brothers. He owned the Florentine Hotel, where I worked," Dashiel said. "He's gone mad. Lost his wife and kids and so has gone mad." Meanwhile they made their way to the helicopter and got in, Edwina in pain and with difficulty.

Inside the camp most of the CAT team, disobeying orders, had come out to see what was happening. Bartlett was concentrating on his official protectors. "Out," he told Lieutenant Johnson. "Your work's finished in here. Get your men out." Meanwhile Gianni's bullets glanced whining off the tough metal of the perimeter.

"Out to be killed by that bastard? We're staying with you."

The platoon sergeant came puffing toward them. "For Christ's sake, we need ammo. Those was blanks. Some stupid bastard made a mistake." He looked back sweatily at the writhing bodies felled by Gianni, their lethal car driven by Salvatore getting nearer the camp's main gate, Gianni bursting away.

"Ammunition's no good to you," said Bartlett. "It won't get through that fence either way. You're safe from that gun."

"Not if we have to go out," said Lieutenant Johnson reasonably. "This mad bastard here," he told his sergeant, pointing at Bartlett, "wants us to take the men away. Christ knows where to."

"Get your men to the transport lines," said Bartlett.

"See here, mister," the sergeant said. "We don't obey no civilian orders. We're staying right where we are."

"You're not," Bartlett said.

"You pretending to give me a fucking order, mister?"

"Not you personally," Bartlett said. "Not from now on." He stepped back five paces, put his Hutchinson hipman to his hip, and then fired a brief burst. The sergeant, with a look of utter amazement on his honest broad face, went down. The ground, like a sprung mattress, bounced him up an instant. Then he lay as still as could be expected. The lieutenant and O'Grady looked

"We do have a 'hire the handicapped' policy, Mr. Norton, but I'm afraid that it doesn't apply if you're two dimensional."

on Bartlett in awe. Bartlett said, "I'll shoot your entire platoon, man by man, if I have to. Get them out of this camp."

"And let the fucking invaders in?" O'Grady asked in disbelief.

"One thing at a time," Bartlett said calmly. "You're mad, Bartlett. You're just plain fucking mad."

"Insubordination. I'll have to rehabilitate you myself, won't I? Later, of course. Lieutenant, you heard what I said."

Johnson looked again at the corpse of his sergeant. He couldn't believe it. "That corporal of yours would make a reasonable target," said Bartlett, readying his gun. The lieutenant blew a shrill whistle, again, again, again. Raggedly his men got into three ranks, corporal as marker. Johnson marched them, giving shaky orders. Gianni had apparently finished blasting for a time.

Beyond the gate Calvin Gropius could be seen. Gropius tried again. "I'm not condoning this man's acts of violence. These two men are not with me. I'm asking you in the name of the Lord to allow only his messenger to enter."

Gianni, of course, heard that very clearly. "The bastard," he said in English. "After what I done for him, killing those guys. You mean you don't want us in there with you, reverend?

"Be reasonable," Gropius said. "For God's sake, think. I'm not trying to save people. I'm trying to save the Word of the Lord."

"*Protestante*!" Gianni grinned terribly.

Two trucks appeared, closed, tough-plated monsters with soldiers inside them. They lumbered, nervously it seemed, toward the gate. The gate, however, was electronically locked.

Lieutenant Johnson looked nervously out of the passenger seat of the cab of the leading vehicle, making a key-turning gesture with some diffidence.

"Unlock that gate right now, O'Grady," Bartlett ordered.

"And let those bastards in?"

"Unlock it. You know the code. Dolphin E4, night."

"You're mad," said O'Grady, scowling. But he took out his pocket activator and set it to 7388026. The gate slowly swung open. The trucks started to move out. Some of the troops let out a feeble soldier's cheer. Calvin Gropius, who had always kept himself fit, sprinted to the opening and, crying "In the Name of the Lord," tried to squeeze himself in. Hipfire resumed on the *bastardo*. He went down, sobbing "In the Name of the—" The first truck went heedlessly over him, then the second. The helicopter hovered very low. It, too, gave off rapid fire. In a blast of filial vengeance, Gianni, screaming, dropped his gun, clutched his ruined face, and at once knew whether there was a hell or not. Another burst to finish him, quite supererogatory, got Salvatore, who looked up as at the sudden fall of gentle rain. He went down very quietly.

An amplified actor's voice came from the skies. "How does the damned thing—Ah

CONTINUED ON PAGE 128

"Something spectacular will happen in 1982, and Minnesota will be the place"

ANTI MATTER

UFO UPDATE

Leaving his companion Laverne Landis behind in his car, electrician Gerald Flach crawled off through the snow-bound Minnesota pine forest. He managed to reach the highway only to sprawl unconscious alongside the road.

"We were waiting for a UFO," he mumbled to the incredulous motorist who found him. "I think my friend might be dead."

Flach's bizarre adventure began in June 1982. At the time, he was vice-president of a St. Paul, Minnesota, group called Search and Prove, whose members claimed to carry on telepathic discussions with aliens from space. Flach was sitting through a peaceful [illegible] meeting when comember Landis [illegible] told him she'd heard from extraterrestrials who [illegible] save mankind if she agreed to meet them [illegible] ness for a ride aboard their ship. Landis [illegible] Flach to join her, and he quickly agreed.

To meet up with the UFO, Landis said, they [illegible] follow the aliens' instructions, no questions asked. [illegible] began their six-month journey. While Landis spewed [illegible] structions allegedly emanating from space, the two traveled to countless rendezvous sites throughout the Midwest and Canada. After months of dead-end [illegible], Landis finally received what would be her last [illegible] nique: Go to Minnesota's Loon Lake and stop eating.

The two made their way to the muddy shore, subsisting on vitamins and lake water for a month. Then on the night of November 14, an unexpected snowstorm pounded their car. The battery died, and the vehicle could provide no heat to fend off the subzero temperatures. The couple began fading in and out of consciousness. "Don't worry," Landis would moan, "they won't let us die." But when Flach awoke, he looked down to see his friend's face puffy and blue. He made his way to the highway, where the helpful motorist found him and took him to nearby [illegible]ok County Hospital. There Dr. Michael DeBevec broke the news: Landis was dead. She had succumbed to starvation and cold.

When asked to comment, Jerry Gross, president of Search and Prove, said that his friends' strange escapade was "truly miraculous." Gross claims that when the pair left town, "everyone assumed that they were lovers and that they'd be back when they cooled off." But now Gross is [illegible] that Flach did meet up with the aliens, learning [illegible] save humanity.

Back in St. Paul, however, some people say that Gross brainwashed the pair into going on their tragic mission. They believe that the group is a crazy cult, and Gross a kind of Reverend Moon or Charles Manson. And they cite a 1978 article in the *Minnesota Dispatch*: "Something spectacular is going to happen in 1982," Gross is quoted as saying, "and Minnesota will be the place."

The mystery will go unsolved until Flach himself speaks up. But as a young boy who answered his home telephone put it: "We don't know where he is, and even if we did, we ain't telling *you*." —*PETER RONDINONE*

HAIRDRESSING FOR THE DEAD

Noella Popagno, of Holly wood, Florida has written the world s first and only textbook on desairology—the art of hairdressing for the deceased

'In the past Popagno explains funeral directors gave the task of hairstyling to their untrained wives or daughters So accidents would happen One woman for instance ironed a corpse s hair until it turned yellow and fell out Now

imagine how the family felt at the wake when they approached the casket

To avoid such disasters Popagno tries to get professional beauticians involved by dispelling their overriding fear that the dead will move about The deceased, Popagno admits, do flinch or twitch from time to time whenever embalming fluids make their muscles contract "But she adds ' in thirty-five years of working with the dead, I've never seen anybody sit up and crack a joke

Popagno's manual is designed to prepare hair dressers for those situations that never pop up with live subjects Take the case of a customer who s had a cranial autopsy In that instance the subject has a horseshoe incision cut along the crest of the scalp and from ear to ear Since the scalp may be sewn back so that hairs mix with the thread Popagno warns, 'it s advisable to hold tresses in place while combing rolling and styling Otherwise you might see the entire scalp fall off.

"Families need an acceptable last image of the deceased to help them get over the shock of death ' Popagno says And the desairologist is a crucial part of that process Anyone interested in entering the field, she adds can get a copy of *Desairology* from J J Publishing 1312 Arthur Street Hollywood FL 33109 The price $13 95

—Peter Rondinone

Castles in the air are all right until we try to move into them

—Anonymous

REMEMBERING PAST LIVES

When regressed back to childhood and beyond hypnotic subjects often recall previous lives in distant eras and cultures Sometimes the subjects even come up with uncannily accurate historical information But according to *All in the Mind* a new book by British author Ian Wilson many of the most highly touted reincarnation claims can be explained by hidden memories based on the subject's present-life reading and experience

Wilson did his research by attending regression sessions and listening to numerous tape recordings allegedly describing prior existences Then ferreting out historical facts he read dozens of books and traveled thousands of miles to check the evidence In case after case he found that subjects had drawn their detailed stories from readily available sources

One woman that Wilson studied for instance, remembered being tried for witchcraft in sixteenth-century Chelmsford, England Her story and the historical information were impressive enough But she said her trial took place in 1556 although the real Chelmsford trials were held in 1566 A seemingly trivial error, perhaps but Wilson subsequently learned that the chronicle upon which most contemporary authors base their information dated the Chelmsford trials in 1556 as well

In another instance Wilson studied an Englishwoman who had recalled an entire series of past lives under hypnosis, including one in the Roman Britain of the fourth century A D Wilson traced much of her information including fictitious names to a historical novel by Louis de Wohl

Though there are some people who may be disappointed to see reincarnation undermined Wilson believes that his findings are all for the good They prove that we all hold within ourselves "a dynamic ever-restless kaleidoscope of images he says ' the complexity of which we have scarcely begun to grasp

D Scott Rogo

"There are a few billion planets, and among these a few million no doubt have civilizations more advanced than our own They will have a different concept of reality '

—Arthur Koestler

SERVING TIME IN SPACE

The first wave of settlers in space is bound to be explorers adventurers and scientists But the second wave could well consist of murderers rapists and terrorists a Canadian criminologist contends

Overcrowding in prisons is worsening as prospects for space colonies improve, observes Ezzal Fattah of Simon Fraser University in British Columbia and these trends support the punishment will lead to an ever-increasing prison population in facilities already at maximum capacity

Fattah explores this thesis fully in his forthcoming book *Are Prisons Necessary?* in which he also discusses other technological alternatives to incarceration It will be possible in the near future to control movement without immobilization Fattah says "to curb violence without segregation and to protect society without incarceration " For example surgically implanted radio devices could be used to monitor the location of a prisoner If the prisoner stepped beyond a certain geographic limit, guards could instantly track him down and return him to justice

Fattah predicts that only the fiercest criminals will inhabit jails in space After all it would be most economical to send those convicts with life sentences establishment of extraterrestrial jails

"This is not something I'd like to see happen Fattah says " It is a prediction based on a historical reading of social control " In the eighteenth century Fattah reports the British solved the problems of crowded expensive-to maintain prisons and the need for cheap labor in the new colonies by transporting criminals to America and Australia In the twenty first century history will repeat itself especially since the likely abolition of capital

— Dava Sobel

"Hitch your wagon to a star

—Ralph Waldo Emerson

TO BUILD A PYRAMID

Not by myriad slaves nor by divine or UFO intervention were the Egyptian pyramids built a Boston engineer asserts but with forethought diligence and an ingenious contraption known as the wheel

The secret of assembling the great royal tombs came to John D Bush soon after he bought an abandoned granite quarry near Gloucester Massachusetts Struggling fruitlessly to nudge a 16-ton block with wedges and jacks Bush hit on the idea of making the block the axle of a giant wheel He built four pieces of curved wood and strapped each one to a different corner of the block creating the configuration pictured above He was then able to roll the boulder with relative ease The technique worked so well he felt somebody must have thought of it before

The engineering problems of building the pyramids seemed the most obvious parallel Bush says So he looked up texts about ancient Egyptian masonry and found a device called a "cradle that was a dead ringer for his makeshift contraption But the archaeologist authors guessed that the cradle had been used as a wedge It never occurred to them that you need a set of *four* cradles to get anywhere " Bush asserts "But then they were sitting down with an artifact, trying to figure out its use I was trying to move stone

At an outdoor demonstration Bush staged last year in Boston crews of six to ten out of shape volunteers found they could haul 2 5-ton concrete blocks up a steep ramp almost effortlessly on the cradle principle With the help of a similar device Bush concludes a few thousand Egyptian laborers could have built a pyramid in 20 years — Dava Sobel

TRAVEL BY PROXY

It's a rainy Sunday. You call the foreign city of your choice and order a proxy, a small robot equipped with TV cameras, audio intercoms, artificial arms and wheels. Then, with your home TV hooked to the robot by satellite, you're set for a day along the *Champs Elysees* or Oxford Street without ever leaving your living room.

Just flick on your TV set, says David Yates, the London computer scientist who thought up this scheme, and city streets instantly appear on the screen. Since you set is equipped with a steering wheel, you might begin driving your proxy toward the city's marketplace. Once there, you could instruct it to pick out souvenirs, bargain with shop owners and have the purchases sent to your home.

While early-model proxies might provide only visual and auditory information, Yates speculates, later models would give their owners a complete sensory experience. You'll actually taste that frothy cappuccino from the cafe in Rome and feel that luxurious Japanese silk. Scientists have already electronically linked an amputee's nervous system to an artificial limb, making it possible for him to feel what his limb feels, Yates explains. So perhaps a technological advance will make a similar link between a traveler and a proxy—without amputation.

But don't throw out that Club Med membership, at least not yet. The high cost of a proxy's sophisticated equipment, Yates admits, will make it unaffordable to the average consumer for years. And even when the price comes down, critics will have to be appeased. After all, as they legitimately note, criminals might steal the proxies and use them to mug the elderly, rob banks or murder.

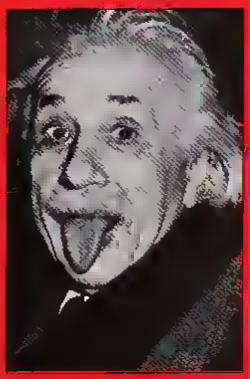
Once perfected, however, proxies will provide a mind-broadening alternative to travel, in much the same way Yates says that cars provided a new and exciting alternative to walking. —Peter Rondinone

The divine art of miracles is not an art of suspending the pattern to which events conform, but of feeding new events into that pattern.
C. S. Lewis

WALK-INS

Every morning, author Ruth Montgomery places her fingers over the typewriter keys and meditates. Then, presto: Words tumble onto the page, dictated straight from the mouths of spirits. In fact, Montgomery says, that's how she's written all her books, including her best seller about psychic Jeane Dixon.

One day recently, the spirits startled Montgomery with a prediction. In the year 2000, the earth will shift off its axis, unleashing quakes and tidal waves. But the human race will persevere, thanks to walk-ins—spiritual saviors who take over the bodies of lackluster people on the brink of physical or emotional collapse.



Communicating by means of the typewriter, Montgomery's supernatural informants have revealed the names of numerous people possessed by walk-in spirits throughout history, including Jesus Christ, Christopher Columbus and Charles Colson. Montgomery, who has spent weeks studying these individuals, reports that each and every one had experienced inexplicable personality changes after a devastating illness or psychic trauma.

The lives of 17 living walk-ins have become the subject of Montgomery's new book, *Threshold to Tomorrow*. She writes, for instance, about Swedish scientist Bjorn Ortenheim, who was sitting on a windswept beach plotting suicide when the brilliant soul of Albert Einstein (above left) entered his body. Today, Montgomery says, Ortenheim is refining Einstein's theory of relativity. (He's already changed $E=mc^2$ to $E-mc^4$.)

Another walk-in is the late Egyptian president Anwar Sadat (above right). During World War II, Sadat was an angry, dispirited revolutionary languishing in a prison cell. Then, Montgomery contends, a great Egyptian soul walked into his body, creating the powerful head of state Sadat's soul, she adds, may very well return to help solve the Mideast crisis—this time with a new name and appearance.

Montgomery's claims may seem spurious to some. But at least her publisher, G. P. Putnam's Sons, in New York, is convinced. *Threshold to Tomorrow*, the company declares, is a survival manual to the new age. —Kathrine Jason

"We are the mimics. Clouds are pedagogues."
—Wallace Stevens

LIFE

CONTINUED FROM PAGE 20

the helpless swimming beasts from afar—a much less dangerous and considerably more productive hunting strategy than stalking them with spears at close range. Moreover, with fishhooks they could catch the teeming salmon in the estuaries almost without effort. And at the height of cave art, some 15,000 years ago, there was also evidence of long-distance trade, larger, sedentary communities, and the first signs of rank and status in what had been from time immemorial egalitarian societies.

Pfeiffer thinks these people experienced an "information explosion" due to vast changes in technology and social structure. And because the footprints of children are so prevalent in many of these caves, he theorizes that ancient cave ceremonies were initiation rituals, rites of indoctrination designed to teach the young huge quantities of new information that they needed to remember in order to survive.

It is curious how you can make a human being effectively remember complicated data. First you make the recipient open to your information. This is done surprisingly easily by stripping the individual of his normal sensory world and replacing it with isolation and monotony—two elements the human brain cannot withstand. Apparently in less than a day the displacement and dissociation put the average person in a trance, a dreamlike state in which he is susceptible to indoctrination and suggestion. Then, after you tell him what you want him to remember, you reinforce the message by frightening him.

The Australian aborigines are masters of memory, and until quite recently they used this method at their puberty ceremonies. This rite of passage began when the male initiates were removed from home and family, taken to secret places in the desert, denied food and clothing, and told the tribal myths. Then, on the last night of the ritual, the youngsters were concealed under blankets beside a roaring bonfire. And after the chanting, darkness, isolation, fear, and disorientation engulfed them, they were led before their elders where their penises were slit from tip to base.

A horrible ordeal, to be sure, yet it serves an essential purpose. These aborigines live in the world's most barren desert, a place almost as uniform as the Pacific Ocean. And if they are to find water regularly, they are obliged to remember every rise, every dip, every tree, rock, and hole within an area of several hundred miles. So every physical feature of the land is woven into elaborate tales of mythical ancestral beings. And as one memorizes the escapades of the gods, the smallest details of the desert become committed to memory, too. Thus, the myths are maps of the outback, and the graduates of the puberty ceremonies have acquired information that will forever guide them from one water hole to the next.

The aborigines also use art in ceremony. On cave walls, on tools, and on themselves they paint series of dots and dashes to depict the wanderings of supernatural beings. These serve as mnemonic devices to recall important episodes—as well as essential facts about the landscape. But the aborigines are not the only people who store data in art forms. Just a glance at a cross could elicit from any American Christian the story of the Christ child, the trials of the Crusaders, the code of the Sunday service—virtual reams of information about the history, beliefs, and practices of those of the Christian faith.

Could the art drawn and ceremonies performed in the caves of France and Spain have served the same function as the desert rituals of the aborigines? Were young initiates left in isolated tombs in the bowels of the earth until their psyches gave way to unreality, then told valuable myths as they were escorted past paintings of dots, hands, mystical figures, and charging beasts that cued and jogged their memories? And, finally, were they led to large subterranean galleries filled with their relatives, where they underwent excruciating ordeals that permanently etched these stories in their minds? The cave art may be what remains of visual aids used as part of a "survival course" given to the children during an era of social turmoil not unlike our Computer Age.

This theory of Pfeiffer's is an ingenious explanation for the blossoming of the first human art. But even more exciting is Pfeiffer's final point. He notes that through isolation, monotony, and rhythm—particularly drumbeats—the human brain becomes very susceptible to trance. And this trance state leaves the individual ready to follow a leader and to believe what the leader says. This observation, in turn, becomes Pfeiffer's springboard into a far more dangerous theoretical realm. "If the pressures of the Upper Paleolithic demanded fervid belief and the following of leaders for survival's sake," he writes, "then individuals endowed with such qualities with a capacity to fall readily into trances *would outreproduce* more resistant individuals." [Emphasis mine.] And, of course, the corollary to this theory is equally provocative: for if trances are found in biology, subject to selection, and easily elicited in human beings, it follows that the predisposition to "believe" is rooted in our genes.

Pfeiffer is not proposing that the proclivity for human worship is a biological imperative—that one *must* believe. Although behaviors like the human smile are inherited (even blind babies smile), most human actions are the result of myriad forces. And for a specific behavioral pattern to be elicited, cultural training and cultural stimuli must be present. Picture your brain as a Stradivarius violin, designed to play in a broad but discrete range. Let culture take up the bow and, with ease, certain notes ring out. If Pfeiffer is correct, religious belief may be a very simple tune. ∞

GAMES

ANSWERS TO GAMES (PAGE 152)

1. CAPITAL. Pierre, South Dakota.
2. CAPITAL. polish.
3. ANYTHING? The items indeed have *nothing* in common. Clocks are traditionally absent from casinos, as are public telephones from racetracks, rats don't vomit (that's why rat poison works), the mayfly has a life span of only seven or eight hours, during which it doesn't eat, and *Foundation's Edge* is Asimov's first certified best seller.
4. TROUNCE. The final score is 16 to 9, not 18 to 9. The home team doesn't bat in the ninth inning if it is winning.
5. STREET. The logical answer is that manhole covers are circular so that they cannot fall into holes, regardless of their orientation. The April Fools' Day extra-credit answer to this question is because manholes are circular.
6. CUT. Because the barber would make twice as much money.
7. DRIVE. Drive backward.
8. CLASSIC. The portrait is of the man's son. Many people mistakenly argue that the man is looking at a picture of himself. If he had said "... that man is my father's son," then this solution would be correct, but he said, "... that man's *father* is my father's son." One way out of the confusion is to substitute the word "me" for the more cumbersome phrase "my father's son." Then the statement becomes, "that man's father is me."
9. TIMELY. The letter *n*.
10. TRIALOG. Of the possible combinations of true and false statements (TFF, FTF, and FFT), the only one that doesn't lead to a contradiction is FTF, which means that Feldman owns no video games at all.
11. OUTSTANDING. The goats are already facing each other.
12. MARATHON. No difference—90 minutes *is* an hour and a half.
13. ELEVATOR. Among several plausible answers, the neatest is this: The man is a midget and can't reach the top buttons on the self-service elevator.
14. JUSTICE. The man was one of a pair of Siamese twins.
15. TOAST. Ninety-one breakfasts. If this had been a leap year, today would be March 31, not April 1.
16 & 17. (LOONY QUESTION and TWO VIEWS) We're saving the answers to these two until next month, because some mulling over is good for you. Answering Number 16 requires knowledge of how moonrise varies from day to day. [Outrageous extra-credit question: Whose face will most likely be seen on TV today within an hour after moonrise? 1. Carl Sagan's, 2. Alan Alda's, 3. Lucille Ball's, 4. Reggie Jackson's, 5. Andy Rooney's.] If you can't wait a month, send a self-addressed, stamped envelope to Games Answers, *Omni*, 909 Third Avenue, New York, NY 10022, and we'll let you have an early look. ∞

EARTH

CONTINUED FROM PAGE 18

bad cement doesn't burn." In the northern district of Niedersachsen, citizens protested establishment of a regional nuclear-waste dump and construction of a street that would have destroyed a small forest. (The construction of the street and the digging of the dump were delayed but not called off.) To the south, in the lush mountain region of Vogelsberg, residents decried a plan to divert water to the nearby city of Frankfurt. (Because the cries went unheeded, the people of Vogelsberg today face serious ecological problems.) Throughout the country, members of these various groups tried to win elections at the state and national level, but without a political party to back them up, they had trouble gaining seats or effecting true change.

Then more than 500 activists assembled at Offenbach. Led by journalist August Haussleiter and parliament member Herbert Gruhl, the group lay the foundation for the Greens. A month later, at the city hall in Karlsruhe, the fledgling party was officially announced.

To Manon Maren-Grisebach, a professor at the University of Heidelberg and one of eleven members in the Green Party's national committee, the scene was sheer jubilation. "There were eight hundred or nine hundred people in the main hall," she recalls, "and TV screens were broadcasting the ceremony for hundreds more waiting outside. Afterwards there was a huge festival. We were totally overjoyed."

When the first rapture subsided, the Greens soberly set out to reconcile differences among themselves. Some party members were concerned mostly with pollution and nuclear disarmament. Other, more radical groups wanted to work for socialist reform. Since change could result only from strength, however, the two factions soon decided to stand by each other. Socialists would fight for forests and rivers, while environmentalists would support a more egalitarian distribution of Germany's enormous wealth.

Now working together, some 3,000 Greens began to broaden their power base, drawing support from disenchanted youth and senior citizens alike. Party leaders sent representatives throughout the nation's cities and towns to communicate with people on a grass-roots level. Wherever the environment was threatened, the Greens organized marches and rallies.

One of the party's first acts was to declare a three-day festival protesting a nuclear-power plant to be built along the Rhine. Thousands came. By the middle of 1980, the party had established a national peace week, with members distributing nuclear-disarmament literature and sponsoring workshops across the country. And in the next couple of years, the Greens became a driving force behind the nuclear-freeze movement. Their success was especially apparent last winter, when hundreds of thousands of Germans braved bitter cold and snow to attend a Green Party demonstration against the Pershing nuclear missiles.

With a strong stance against nuclear weapons and nuclear energy, Green Party membership has recently grown to 25,000. Millions more voted for the Greens in local and federal elections, making the group the first truly powerful environment-based party in the Western world.

The party has already captured 48 seats in Germany's state parliaments, and both Chancellor Helmut Kohl and former Chancellor Helmut Schmidt admit that the Greens constitute the country's fourth-largest political force. If the most recent polls are correct, the Greens will overtake the unpopular Federal Democratic Party and become the nation's third most important political group. This would be the first major change in the character of West German politics since the end of World War II.

Once the Greens make these gains, explains University of Berlin political scientist Theo Pirker, they might well have a dramatic impact on Germany's national policy. For example, if the two primary parties stood deadlocked on an issue, with 45 percent of the vote each, and the final 10 percent rested with the Greens, the Greens would cast the deciding vote. Even if the Greens refused to vote along with either of the major political parties, their voice of "opposition" would sound far and wide.

Some experts believe the Greens may eventually gain enough popularity to abandon their opposition role, becoming a fully contributing third political partner. If that happens, according to Eugene Odum, director of the University of Georgia's Institute of Ecology, the Green movement might spread around the world.

"The problems that gave rise to the Green Party are common to industrial nations everywhere," Odum explains. "What many people seem to forget is that you *need* clean water, forests, and open space to provide your life-support system. We in the United States haven't yet faced enough destruction to see a clear danger, but that point will come. And when it does, you might see all sorts of Americans joining forces to form a party like the Greens."

"Industrial growth," he concludes, "is like a little kid. Everyone likes to see him get taller and put on weight; that kind of growth is fine. But Germany is grown-up, and any more growth is cancer."

In the world according to the Greens, each dead river, vanished forest, and new construction site is one more symptom of malignancy. Party leaders admit that their ideas are new and their means untested, but with no known cure, they feel radical treatment is justified.

"The next step leads to an uncertain future," says Maren-Grisebach. "It's like going into a dark forest. But if we're not sure where we're going, of one thing we're positive. We know where we've been." ◻

INTERVIEW

CONTINUED FROM PAGE 106

advanced countries. We have unemployment, but Mexico has vastly higher unemployment.

To take the extreme example: the average productivity of a worker in the United States has increased five times since I don't know, 1920 or something like that. So you would expect that four-fifths of the population would be out of work.

Omni: But obviously when automation comes in, people *are* out of work temporarily and then go to something else.

McCarthy: That's right. Now there is an economic malfunction that causes unemployment—that causes this interaction between unemployment and inflation and so forth. But it seems to me that this malfunction has little, if anything, to do with technology. What seems clear is that nobody knows how to deal with unemployment.

Omni: That's taking automation only up to a certain level. But if we go up to the next level and have smart robots, I would imagine there would be a fairly major shift in people's ways of life.

McCarthy: There was a soap opera of the Thirties in which a girl from the hills of Kentucky married an English lord. The question was, "Can a young girl from poverty-stricken Kentucky adjust to life among the English aristocracy with dozens of servants and so forth?" And the answer was that one has a real hard time adjusting—sometimes it takes all of ten minutes. So it seems to me that what we would have to adjust to is being rich. It could take all of ten minutes.

Omni: What about the psychological benefits of being rich? If everyone had chauffeurs, maids, and servants...

McCarthy: I don't think that's really important. If you read nineteenth-century literature, you don't find any indication of people taking pleasure in their position relative to their servants. As far as they were concerned, servants were part of the machinery. It doesn't seem to me that you will lose a very large part of the psychological benefits of being rich merely because other people are rich. As the saying goes, "Anybody who is anybody."

Omni: That raises another question. How do we deal with machines? People who work with home computers have a funny way of talking about them. "It likes" and that sort of thing.

McCarthy: In my view, verbs like *believes, knows, or doesn't know, can do, can't do, understands,* or *didn't understand* are appropriately used with many present computer programs. And such language will become increasingly appropriate.

Omni: There's a certain amount of humor involved when people use personal terms to refer to machines.

McCarthy: Yes, there's also a lot of purely metaphoric use of these phrases, even in relation to old machinery, which is not really appropriate. That is pure projection. Of course, with regard to computers that projection takes place. But there's also the appropriate use, and eventually the pure projection and the appropriate use will be inextricably entwined.

Omni: Do you think as we move toward more automation that we are going through a period of Luddism—revolt against the coming of robots? It seemed as if we were doing that for a while in the Sixties. But that seems to have subsided now.

McCarthy: It seems to me that the cause of those incidents had nothing to do with computers. It was a social phenomenon of some kind that we don't clearly understand. If computers were the cause, the cause hasn't gone away. The impact of computers on daily life was much more profound during the Seventies than it was during the Sixties.

Omni: What about the predictions of millions of people suddenly being put out of work by automation?

McCarthy: That's by no means a prediction. That's merely a speculation as to what could cause Luddism on a substantial scale, and I don't think people would be quite so dumb as to do it. To say something else: it seems to me that if we are all to be rich there has to be a lot more progress in automating office work. More than half the U.S. population now works in services of one kind or another, and we won't be rich unless we succeed in automating those.

Let me repeat a story someone told me about his vision of the future. A clerk in Company A hears a beep. She turns to her terminal and reads on the screen: WE NEED 5,000 PENCILS. ORDER THEM FROM COMPANY B. So she turns from her terminal to her typewriter, types out a purchase order, and sends it to Company B, where another clerk reads the order, turns to her terminal, and types in SEND 5,000 PENCILS TO COMPANY A. The person who related the story told it as far as I could tell, with a totally straight face. But what do we need those two clerks for? Why don't those two computers talk to each other? Interorganizational communication by computers is something that's hardly started.

Omni: We're getting to the point where we have terminals that do communicate with each other. Of course, they don't communicate much.

McCarthy: My main complaint about technology has been the slowness with which it is developing. My impression is that the rate of technological innovation, so far as it affects daily life, has been slower, say, between 1940 and 1980 than it was between 1880 and 1920. So people who complain about technological change going faster and faster are simply wrong. A lot of the complaints are in a sense complaints that technology is advancing too slowly, that the individual doesn't see nearly enough improvement in his own lifetime.

Some important improvements are not appreciated. You don't spend five minutes a day thanking technological improve-

ments in sanitation and housing for the fact that you and your children don't have TB. The normal attitude is to take health for granted until you don't have it anymore, and then you complain. The same is probably true of wealth, insofar as technology has really contributed to your getting a higher salary than you would earn otherwise. But you don't see the contribution that some specific invention has made to your increased salary.

It's interesting to look at what inventions could have been introduced thirty or fifty years before they actually were—the missed opportunities where the technology was available to build them. And there are a fair number of them.

Omni: Name one.

McCarthy: Well, I have a white-disc push-button combination lock on my front door. I can open it much faster than I could a key lock, especially in the dark. Mechanically it's no more complicated than a key lock. It could have been invented one hundred years ago.

Another is the pulse jet engine. Are you familiar with it? Its only application was the German V-1 rocket during World War II. It is a very simple engine. Gasoline is squirted in and the jet explodes out the back end. The momentum as it goes up creates a vacuum that sucks air in the front, so that the thing goes "phutt-phutt-phutt-phutt." There is nothing in the technology of that engine that would have prevented its being built in 1890, and it's vastly simpler than a piston engine.

Omni: You and Marvin Minsky propose different solutions to the question of artificial intelligence and common sense. Can you give me a brief description of the two different points of view?

McCarthy: Minsky is skeptical—one could say more than skeptical—about the use of logic in artificial intelligence. But I and some others are optimistic about the use of logic to express what a computer can know about the world. What's clear is that some modifications are required, and I expect to make progress using various forms of formalized, nonmonotonic reasoning. And Minsky is skeptical about whether that will work.

But actually that's not quite the whole story, because in addition to his skepticism about what won't work, Minsky has positive ideas about what will work.

Omni: Can you describe his ideas in simple terms?

McCarthy: Maybe he can! I can't. I can mention an idea of his that I'm skeptical about. This is the notion that in any particular situation, there is a dominant "frame." Minsky and Roger Shank, of Yale University, have pursued this idea. The restaurant frame, for example.

Omni: Meaning that when you walk into a restaurant, you enter a context in which you speak, act, and understand things in a certain way that would make no sense if you were, say, in a skating rink?

McCarthy: Right. Put that way it's almost a truism. But the notion of a single dominant frame with subframes and so forth can be contrasted with the notion that information from a variety of sources interacts to define the situation. In other words, is the situation always dominant, or is it dominated by a frame?

Here you are interviewing me. That is a frame. One could put some slots into that. But if we actually tried following the details of the conversation, would the frame concept allow for that? It works fairly well at the top level. You have a collection of questions that you want to discuss, so at that level it works quite nicely. This interview with me is, in that respect, very similar to the interview we did for your book [*Scientific Temperaments*]. Or from my point of view, being interviewed by you is similar to being interviewed by someone else. But if you're not bored by this particular interview, that must be because it is. In some important way, different from the others. And that isn't quite caught by the frame.

Now Shank, who writes a lot of computer programs, seems to be finding that in order to make things work he needs "packets" of information that interact with one another, no one of which is dominant. And from my point of view, I would say "Ah, yes, Shank is moving in the direction of logic." But how that'll come out, I don't know.

Omni: These are all approaches to the same problem—how to represent knowledge?

McCarthy: Well, yes. Minsky and I have come to agree that the key thing is commonsense knowledge.

Omni: Give me a definition of commonsense knowledge.

McCarthy: Well, compared to scientific knowledge, one might define it as events

taking place in time and space, and knowledge about knowledge—things like that. If I ask you, "Is Andropov standing or sitting at this moment?" you will say, "I don't know." And if I say, "Think harder," you'll say, "That won't help." The question is, how do you know it won't help to think harder? And if I ask you, "Does Andropov know whether you are standing or sitting?" the answer certainly can't be determined by inspecting any model of Andropov's mind.

Omni: I'm trying to get a sense of the difference between a logical approach and this frame approach to representing knowledge.

McCarthy: From a logical point of view, the ideal—and I'm not a purist—would be that general commonsense knowledge can be represented by a collection of sentences in a logical language, and that your goals can also be represented by such a collection of sentences.

If *x* is a bird, and birds can fly, then *x* can fly—that's one argument I've been using that sentence because Minsky gave it as an example of how little logic is good for. His argument had to do with the fact that there are many exceptions. A penguin, an ostrich, or a dead bird can't necessarily fly. But maybe in a sufficiently dense atmosphere and at sufficiently low gravity an ostrich could fly. So the exception has the potential of being true.

Omni: With your nonmonotonic logic you can get around all the qualifiers by adding a phrase that says, "If nothing prevents it."

McCarthy: Basically, yes.

Omni: And then to check that, you have to go elsewhere, to other sentences. What prevents birds from flying?

McCarthy: Right. And in particular, what prevents this specific bird from flying? What, if anything? And you have to do what's called nonmonotonic reasoning. Namely, you have to assume that this particular bird can fly, unless you know something about this bird that prevents it from flying. And the reason it's nonmonotonic—are you familiar with the mathematical notion of monotonic function? Ordinary logic is monotonic in the conclusions that you derive from assumptions. In other words, if you add more assumptions, then the conclusion that you could previously derive can still be derived, possibly along with other conclusions. Ordinary reasoning has nonmonotonic aspects. If I tell you that Tweetie is a bird, you will infer that Tweetie can fly. But if I added the fact that Tweetie is an ostrich, you would no longer make that inference. So this requires some modification of the reasoning structure of ordinary logic in order to get this nonmonotonic character. But those of us who like logic think we can modify logic to accommodate the problems of the real world. That something of the kind was required has been known for a long time. Ideas on how to do it formally and still preserve the formal character of logic were first being developed from the middle to late Seventies.

Omni: Do you imagine some such logical system might operate within the brain?

McCarthy: What operates in the brain, I think, has got to be different. But I don't have a clear picture of it.

Omni: So the idea is that regardless of what actually functions inside the brain, these things can be done logically in computers? Do they have to be done logically?

McCarthy: No, they don't have to. You can design a computer program that will make logical mistakes.

Omni: Is an expert system a good example that demonstrates Minsky's idea?

McCarthy: Some of the expert systems work according to still a third ideological basis. It's a belief that if you just pile things on top of one another, this knowledge can be directed—that no theory is required.

The expert systems lack common sense. The example I usually give is MYCIN, which is a Stanford system that gives advice on bacterial diseases. It has no concept of events occurring in time. It has no concept of "patient," "doctor," "hospital," "life," or "death." It does have concepts of the names of diseases, names of symptoms, names of tests that may be performed, and so on. And it converses in a sort of English. But if you were to say to it, "I had a patient yesterday with these symptoms, and I took your advice and he died. What shall I do today?" it would just say, "Input ungrammatical." It wouldn't have understood about the patient dying. It doesn't need that information for its purposes. But in spite of all that, it's quite useful. To some extent it's a kind of animated reference book.

> *"The human instinct to assert independence is something that would require some effort to build into a robot. It doesn't seem to our advantage to make such an effort."*

Omni: That's a very good term for it, because it eliminates the notion of common sense, which most people automatically assume is there when they see a machine making a diagnosis.

McCarthy: MYCIN is a particularly limited system. The interesting thing—similar to what I was saying about robotics—is that people are discovering how to get around the unsolved problems and make systems that are useful, even though these systems can't do some of the things that are ultimately fundamental to intelligence. I talked before about the usefulness of some of these very limited vision systems, and here we have MYCIN, which is useful, although very limited.

Still, I take a more basic research-oriented point of view. These people make their very ad hoc useful systems and that's fine. But I think the fundamental advances in artificial intelligence will be made by people looking at the fundamental problems. Now, for some reason, artificial intelligence is the subject of a great deal of impatience. When it had existed only for five years, people were saying, "Yeah, yeah, you've been unsuccessful." But when we compare it to, say, genetics, in which just about one hundred years passed from the time of Mendel to the cracking of the genetic code. Now, there may have been periods when people thought they would be able to create life in a test tube by 1910 or something like that, but we don't remember that today.

Omni: Why do you suppose there is this unwarranted excitement and anticipation?

McCarthy: Well, there's always been unwarranted anticipation in science on the part of some people. I think some of the expressions of disappointment are disingenuous—people taking the fact that it hasn't succeeded so far as evidence that it won't succeed at all. On the other hand, there has been some overoptimism within the field. Partly that's because if you see only certain problems, you can imagine a plan for overcoming those problems. But if there are more problems that you *haven't* seen, you will be disappointed.

Omni: Decades ago, long before the enactment of the Privacy Act of 1974, you advocated a bill of rights, published in the September 1966 issue of *Scientific American*, to protect citizens from the abuse of information collection made possible by computers. You advocated national data banks as very important social tools, but wanted to assure that their contents would not be misused.

McCarthy: I made a proposal for dealing with the misuse of information: that a person had a right to know what information about him was in the data banks, that he could sue for invasion of privacy, that he could challenge information in the file, and so on. I don't know whether my article had anything to do with it, but in many places these ideas have been incorporated into laws and the thing has been elaborated upon considerably. Now I'm beginning to think my 1966 proposals were a mistake.

Omni: Why?

McCarthy: To some extent they pandered to superstition—the superstition that people can and will harm you on the basis of trivial information. For example, Princeton University is worrying about whether my privacy would be violated if they release a photograph of me to *Psychology Today*. It's a little bit like some primitive superstition that if you have a person's nail clippings and a few locks of hair you can cast a spell on him, or that if you know someone's true name you can harm him.

Omni: Don't you think there is some value

to personal privacy for its own sake?

McCarthy: Yes. I suppose so. But it has been taken to extremes in Europe, especially Sweden. They have all these flaps about transnational flows of data. It's nonsense. I'd rather build a legal fence around actions than around information.

Omni: What do you mean by that?

McCarthy: Certain actions might be illegal, like discriminatory denial of credit or something. But from all this caginess it has resulted now that people think they have a right to see their letters of recommendation and so forth.

Omni: I hadn't heard of that.

McCarthy: Oh, there's a big flap in the universities. But they've reached a reasonable compromise here at Stanford. A student can waive his right to inspect his recommendation. Of course, nobody's going to believe a recommendation unless that right has been waived. In other words, if I write a recommendation for somebody and it says on the form that he has the right to look at it, the person to whom I'm writing is going to say, 'Well, this isn't worth anything, because if McCarthy knows any adverse information he won't mention it.'

And then you get busybodies getting involved in inspecting databases to be sure they don't contain any information that shouldn't be there. Stanford has this rule that any questionnaire must be cleared with the Committee on Experiments with Human Subjects unless it's specially exempt. I'm supposed to get approval on all questionnaires because, who knows, one of my questions might offend somebody. So I've told the committee I am going to send out a questionnaire and not tell them about it. I haven't got around to it yet—I haven't figured out what I want to do a questionnaire on. But somebody has to defy them.

Omni: Well, there's a point in there somewhere. Isn't there? Your brother Patrick was thrown out of the army for admitting to being a Communist, and then later in the Seventies he was dismissed from a post office job for refusing to sign a loyalty oath. I would think that your family's history and experience would lead you to fear the misuse of data banks and information.

McCarthy: But I think that the legitimate protection against misuse of information is at the level of action. In other words, the post office shouldn't have been allowed to fire my brother.

Omni: But they still should be allowed to have access to various kinds of information about people?

McCarthy: What goes into data banks should be a matter of judgment, but I've become convinced that there should be no restrictions on the storage and exchange of information.

Omni: Between, say, the FBI and the IRS?

McCarthy: Between anybody. Even private individuals should be allowed to keep records. If you want to be sure nobody has files that he shouldn't, then you have to be able to snoop in his files.

Omni: So private individuals ought to be able to go to the IRS and take a look at their files?

McCarthy: No. Not exactly. Take another view of it. There is privacy, and there is privacy. In order to be sure that you aren't violating my privacy, I have to violate yours. How do I know what information about me you have stored in the data bank of *The Washington Post*, unless I get the chance to inspect the data bank, in which case I'll find out all sorts of things about you and *The Washington Post*?

Omni: And you ought to have that right?

McCarthy: No. In order to cut off these reverberating violations of privacy, rules should be enforced at the level of action and not at the level of information storage.

Omni: So, for example, the FBI may have a long file on you, but unless they use it to harass, arrest or convict you, then nothing happens?

McCarthy: That's my current view of it. The cost of looking at information and deciding what is valid and so forth is enormous.

> *"I proposed that a person had a right to know what information about him was in the data banks. He could sue for privacy. Now I'm beginning to think my proposals were a mistake."*

Normally it's done only when something is really important. In other words, if you take the Tylenol poisonings, all sorts of random company records that normally are not looked at are going to be scrutinized extremely carefully for whatever clues they might provide—at an enormous cost. If you wanted to examine police files to find out whether they contained information that violated somebody's privacy, it would be almost as expensive. So what you get is something more informal.

I assume that it's standard procedure for policemen to call each other up and say, "Well, we didn't dare put the information in the files, but while we had this guy in jail, he was talking to this other fellow who was involved in drug smuggling."

Omni: I covered the Tylenol story and that is exactly what happened, because at one time the police had to rid their files of certain information. So what they did instead was to get the older members of the investigative force together and say, "Let's go back and try to remember these files we had to get rid of." And they did: they remembered the guys, went out, rounded them up, and questioned them.

McCarthy: They might have forgotten some very important things. Or they might have gotten them wrong and some poor fellow whose actual offense was entirely unrelated was confused with somebody else.

Let me tell you about a calculation I've made. I got interested in the question of how much a safety measure can cost before you actually lose lives by spending money on it. The estimate is made the following way. Take the statistical abstract of the United States and the annual death rate by states and the income by states, and draw a regression line through that. You'll get the result that if you spend more than 2.3 million dollars for every life saved, you are in fact losing lives. Because if that same money were randomly sprinkled through the economy by reducing taxes or something, people who received that money would, on the average, take better care of themselves. Their lives would be happier. But if a state spends more than 2.3 million dollars per life saved through a safety measure, then that state is reducing the disposable income of its citizens. In the long run it is actually killing more people than it saves.

Now take the Tylenol thing. Johnson & Johnson has already spent more than 100 million dollars withdrawing Tylenol from the market. Okay. According to my calculations they must save forty lives by doing so before they reach the break-even point. And the new packaging's going to cost 2.4 cents a bottle. Now if you newsmen had just shut up, then we wouldn't have had these imitation crimes, at least, and one would have been able to say, "The poisoning of drugs is a rare event and it's not likely to occur any more frequently in the future than it has in the past. We will save more lives by not spending the money on safety caps."

Omni: That's assuming you don't report the original crime?

McCarthy: That's right. Or you minimize publicity on the original crime. Merely reporting it probably has less effect than pounding away at it in the newspapers for days and days. Because psychotics probably are not regular newspaper readers, and furthermore, because of their concentration on their problems, the notion has to be pounded into them a bit more before it occurs to them to go and do likewise.

Omni: That theory would be supported by the time gap between the reporting of the original crime and the beginning of the wave of other poisonings.

McCarthy: Now here was a latent disaster, or at least latent harm, that's been sitting around for fifty years or more. Presumably the psychotics who might be inclined to do that sort of thing have existed for a long time, but nothing triggered them. I once thought about what would happen to our society if there really were a lot of poisoners—people trying to poison water supplies. Society would manage to survive, but we might spend ten percent of our GNP on security measures. ∞

WORLD NEWS

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yes, thank you. My name is Willett." The team, including its leader, looked up in wonder. It was all over the camp, that confident histrionic voice, buoyed by the electromagnetic barrier. An actor now resting indefinitely. I have with me here Dr. Valentine Brodie, late in reporting for duty but better late than never. Mr. Dashiel Gropius and Mrs. Edwina Goya, who is about to, ah, parturiate and urgently requires the help of an *accoucheur* or *euse*. Let us come down and land. Remove your piecrust."

Bartlett said to O'Grady. "Let them stay out there."

Vanessa stood, unable to think, even to breathe. Dr. Adams was near her. Gently, like taking a toy from a child who has just dropped off, Dr. Adams untolded Vanessa's fingers and let the warm little gun plop gently into her own hand. She released the safety catch. Vanessa came to, shivering. "Did you hear what I heard?"

"It's your husband, Vanessa. It's Dr. Valentine Brodie."

"My *husband*. How did you know?"

"You've talked of your husband often enough—before correcting yourself, of course. I think everybody will be delighted to see your husband. Better than being mated to Bartlett, Head of Enterprise."

"I can see him—he's waving." And then, fearful, knowing there was much instability about, perhaps even in seemingly sane Maude Adams, Vanessa asked. "Why do you want that gun?"

O'Grady said to Bartlett. "You heard what he said. There's a woman up there who needs help."

"She won't get it from us. This isn't a maternity hospital."

"Deactivate the barrier," said Dr. Adams, pointing the gun at O'Grady. O'Grady, only too glad to obey, did a clumsy half-to-don't-I gesture at Bartlett and loped off toward the concrete block that bore the symbol of a sitting cat, back view, with a single thunderbolt at which, as at a tire, the animal seemed to warm itself.

Bartlett pointed his hipgun directly at O'Grady and shouted. "I'm warning you, do you hear me?"

"Best get it over," said Dr. Adams. "We're short of time." And she very neatly shot Bartlett. Bartlett spun, howling, mad eyes looking for something, somebody, then just staring, holding huge twin gibbous moons. He went down very heavily, and the earth, in temporary repose, did not bounce him. O'Grady saw, coming back, agape, going into an ape droop, unable to believe. He saw Dr. Adams's smoking gun.

Instinctively he went for his own, cold as yet unused.

Dr. Adams said, "Are you going to be a good boy, Dr. O'Grady?"

O'Grady licked his lips nervously. His hand moved toward his hipgun. Dr. Adams shot very neatly at a point just five centimeters in front of his left boot.

"Are you, O'Grady?"

O'Grady grinned sheepishly and shrugged. Then he threw his weapon down. It was a heavy weapon. "Not too good," he said, "that pacifier."

"Alcohol, laughter—those help." Dr. Adams said. "And the odd dose of animal fear." The earth moved rather urgently. The moon seemed to be breathing on them.

"He was mad," said O'Grady, looking down on dead Bartlett. "Clever but mad. Who takes over?"

"Here he comes now." Vanessa said. The piecrust was off. She ran toward where the helicopter was preparing to touch ground. Val, dirty, leaner than he had been, monstrously unshorn, went straight to her. They embraced, at first awkwardly, then not so awkwardly. Edwina, groaning, appeared, upheld by Dashiel Gropius, at the top of the ladder. A storm seemed to be blowing in from the moon. The ground felt like a ship's deck in storm birth. Hecate, matron of women in childbed, looked down in menace. "The ship," said Vanessa. "The ship, from now on."

"Transportation?"

"A dickeybird hop," said Willett. "Back on board. Edwina. Up and in, ladies. I've always wanted to be in a spaceship. And so he set the blades whirring again.

Dashiel Gropius looked down at dead Bartlett and said. "Who did that?"

Everybody looked at Dr. Adams.

"Thank you," said Dashiel. "I didn't really want to do it. I'd promised Edwina, but still—" The corpse heaved gently on its unquiet bed. "I didn't know him, you see."

"Yes, of course," said Dr. Adams. "You have to know him. Have known him," she corrected herself.

"Ah." Val said, eyes on the wall chronometer in the viewing room. "It's the moment."

The crew, or citizens, of *America* were hardly aware of the blastoff. The magnetic gravitation surrogate of the great ship kept steady even the beaker of water that Edwina Gropius put to her lips. It was a three-day trip to growling Lynx. The beast was bellowing, trembling, rippling at the prospect of soon leaping on its prey. What the hell was the thing made of? Pure iron ore? The mass tugged at the craft as it became a new, it diminutive, satellite, circling the hydrogen-misty planet in ninety minutes flat. The crew, or citizens, saw on the great screen a moon lacking all the features that every schoolboy was familiar with: the seismic disasters having ravaged it like some dreadful disease.

Meanwhile, work went on in Dr. Jumel's laboratory. She, a pretty, fair girl, flushed with effort, her attractive low brow corrugated with thought, worked on the epsilon-link equations. Cybernetics and automation cooperated in turning out successive versions of the tiny, complex artifact that would provide the clue to more thrust. The calendar said CAT 10.

The calendar clicked at artificial mid-

night to CAT 9 then CAT 8 followed Artificial dawns artificial noons artificial nights—their ingenious lighting system clung desperately to the only temporal pattern they knew But that must change there must be no buffers against reality Meanwhile Earth grew closer the moon was huge and blinding but not so blinding as Lynx They drank the sun like some strength-giving potion for attack for resistance It was hard especially for Mr and Mrs Gropius to believe that a terrible cosmic drama was in progress outside the tough walls of their world These two cooed at the baby who yelled in self-centered vigor He had a name now Joshua

CAT 7 Val refused to be desperate If the job could be done it could be done by Lilian Jumel If the job could not be done then they would all perish Nobody had any right to life Life was a free bestowal Still as they sailed between the Scylla of moon and the Charybdis of Lynx, between the steam of one and the ravaged face of the other animal panic grew in those few of them who saw the movement toward cataclysm on the plotarchal screens Val dredged desperately into memories of books he had written He found nothing

Then on CAT 6 Lilian Jumel collapsed—overworked, lacking sleep full of despair She had colleagues of course competent but mere journeymen compared with her The megaproagon was her brainchild O Grady quieter than he had been diffidently suggested a pacifier Val said no—a mild hypnotic only And then he thought, *Why use drugs?* The book he had written so many eons ago *The White and the Walk of the Morning* had an amateur hypnotist in it Jess Hartford or Harvey or somebody Val had done his homework he always had While Jumel writhed on her bed in the intervals of waking hysteria Val brought calm to her bedside also a swinging gold watch borrowed from Dashiel Gropius his father's gift to him on graduation He calmed her with the rhythm of gentle light and incantation He got her into deep sleep He spoke to her mind calmly always calmly He said 'There are many ways out of the problem The very bounce of Lynx as it eats the earth may provide the jolt needed the extra split-second boost There are apparently a great number of asteroids spinning about Who knows whether the pull of one of them infinitesimal though it may be may not ease the gravitational problem that faces us?

'There is nothing to worry about You have all the time in the world Things are not really so desperate Nothing is all that important We have all known the rich life of Earth This new space life is a mere bonus a discardable extra Rest dear Lilian Rest as long as you will Everything is being taken care of

On CAT 4 she rose from her bed without a word to anyone except a demand for surrogate orange juice and coffee She showered washed her hair dressed She walked calmly to her laboratory where

Durante, Lopez and Boudinot were knotted over equations. "All right," she said, and they went to work.

On CAT 3, having achieved a velocity that kept the craft continuously retreating from the impending point of collision, Jumel spoke hopefully. And then all work stopped as they went to the great screen to see the end of the moon.

The moon had been circling its new host in a regular satellitic rhythm. But Earth was eventually going to be in the way of one arc of its revolution. This had always been evident, and there had been distracted speculation as to what the moon would do—wobble out of its course, be hurled to the condition of a solar satellite. But what happened now, the obvious, the banal, had always been the expectation of most of the American team. They saw the moon come gracefully wheeling approach the Earth, and then, not brutally, not even rapidly, shatter to fragments against it. The point of impact, they adjudged, was the dead heart of Europe. The moon shattered, and they gasped. Little Joshua Gropius howled, but not for the moon. The moon broke and went into gracefully sailing fragments that slowly changed to sunlit dust, and most beautifully, tried to become a dust-ring around Lynx. But Earth was in the way. A ring spun of most lovely pearly configuration, but at the point of impact with Earth shattered to amorphous dust, only to reform when free of that gross body.

On CAT 2, with no large fanfares of triumph, Jumel announced that they were ready to blast off.

And so, with a desperate-seeming wrenching that even caused a brief dysfunction of the magnetic gravitator, the spaceship *America* broke free of the pull of Lynx and soared into free space, heading in the direction of Mars.

What they all had to see now, and yet did not wish to see, was the end of their own planet. As they sped away from Lynx, they saw on the big screen the great hump of the predator, with its ring satellite that had once been the moon of Shakespeare and Shelley and a million banal songs, growing ever more disjunct, ever more something-out-there. Val assembled the team in the salon. He had never yet worn the black gear that was the uniform of the citizens of this new America, and he came in looking, if anything, scruffier than he had ever been—clad in the worn trousers and sports coat and torn boots of his, and Willett's, anabasis.

He said, "We are, as you know, about to witness the end of the earth. If seems to me that we ought to drink to something—ourselves, our future, perhaps not our past. We have no past, but our future is limitless." Dashiel Gropius wheeled in a portable cocktail bar that had glasses and ice. "Mr. Gropius," Val said, "will soon be the most important man in *America* or on *America*. We must agree sometime as to the more fitting preposition. In his hands will be the organization of games." Most of the citizenry looked puzzled, even affronted. "I mean that all we can reasonably salvage from our past is the game of skill or chance which is based on the abstraction of number. All else—literature, metaphysics, music—must be accounted mere nostalgia, nothing more. What have we to do with poems about love under the sycamores under the moon?"

"Music," said Dr. Adams. "We absolutely *must* have music."

"Only if we learn to make it ourselves. What right have we to listen to instruments long dead, scraped or blown in the service of the glorification of a world that no longer exists? No, we must learn to make our own." Vanessa saw a hardness in him that resurrected the lineaments of Bartlett. But he was a more reasonable Bartlett.

"Let us at least before Earth ends," said Dr. Adams, "hear some of Earth's music." She took from her shoulder bag a music cassette. Val smiled with un-Bartlettian indulgence. "All I have," she said. "And after this performance you're at liberty to liquidate it forever."

"What is it?"

"Mozart's *Jupiter* Symphony."

"The last movement, then. Take this, ladies and gentlemen, as a demonstration of our power, our very human power to enclose through intelligence and skill the huge but crass and stupid events that are the result of sheer blind celestial mechanics. The earth is dead, or nearly. Long live the human world."

The musicassette was inserted in one of the recording machines. Vanessa's finger pressed a golden lozenge on an instrument panel inlaid in the salon wall. From the four corners of the ceiling music poured—the essence of human divinity or divine humanity made manifest through the gross accidents of bowed catgut and blown reeds. And on the screen they saw what that music diminished and made seem remote, even trivial, or else take on the pattern of choreography—cosmic indeed but seemingly humanly contrived. They saw Lynx and Earth meet, and the first patch of Earth to catch the blow was the northern Rockies, which must already be leaping with stupid love to the claws of Lynx. They tasted the heartening fire of gin, its little benignant brutality, as Earth shattered—core of dancing water, crust of dust—and at once formed an outer ring satellite of its successor in the dizzying annals of the sun dance. The moon was a ring, and a greater ring pulverized Earth spun already in perfect concentricity, luminous dust made of the dust of Bartlett and the Tagliaferro brothers and Calvin Gropius and his cat and millions and millions more, all, indeed, who had scratched that fertile surface and watched the wonders of mind rear themselves upon it. Mozart, too, was part of that dusty ring, but miracle, Mozart was also here, tender, triumphant, drowning even the howling of a child. The rhythms of Mozart bore them on into space, the beginnings of their our journey. ∞

SPACE

CONTINUED FROM PAGE 22

report is the data on fusion micropellets. Like many of today's breakthroughs, work on starship fuel depended on help from a computer. The computer program called LASNEX was the creation of another of Wood's young geniuses, George Zimmermann. Zimmermann was newly graduated from Harvey Mudd College in Claremont, California, and was wondering how to avoid being drafted and sent to Vietnam. Wood hired him, got him a draft deferment, and Zimmermann proceeded to turn out a program that is the world's best at predicting the energy released by micropellets of a specific design when zapped with a laser beam of given characteristics.

At Livermore it is routine to use LASNEX to predict what will happen in laser-fusion experiments, then to run the experiments and find close agreement. Hyde has used LASNEX to test the designs set forth in the British Interplanetary Society's *Project Daedalus* report, proposed as a possible starship design. His conclusion: Either their pellets won't ignite, or if they do, they'll produce so many neutrons as to burn up their ship. In the LASNEX simulations, by contrast, his lasers and pellets work.

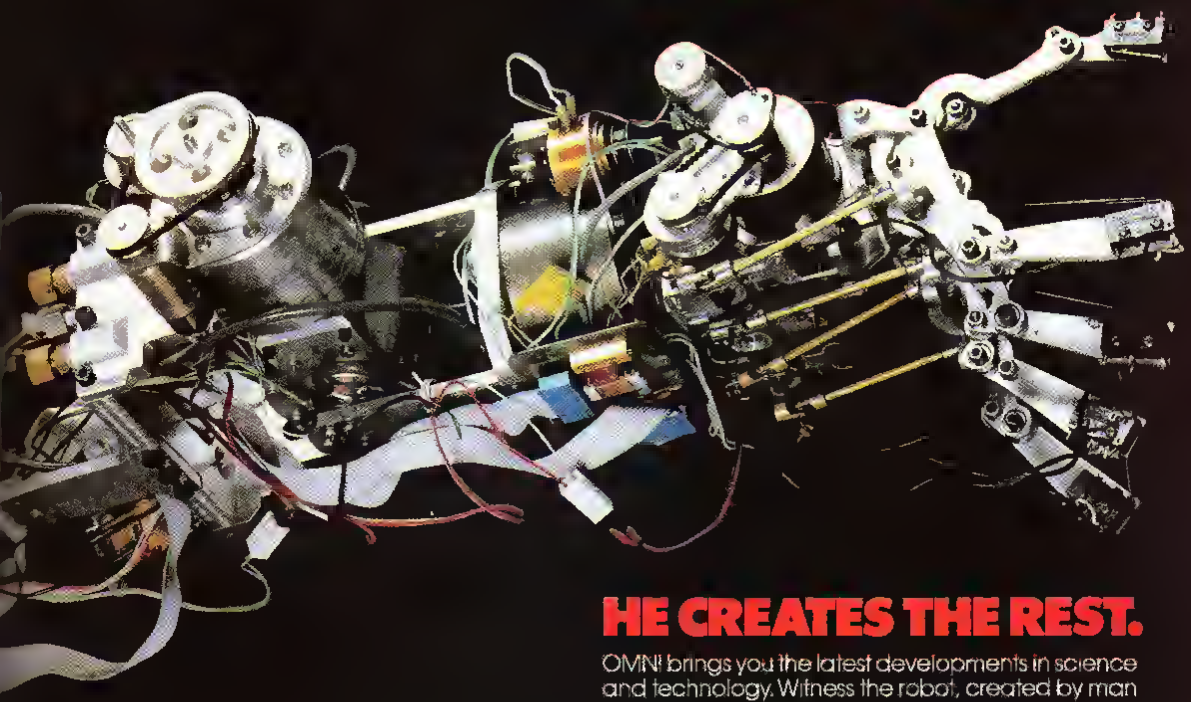
Another thing that's known is Hyde's choice of laser. He prefers a krypton-fluoride excimer device, one of a class of high-performance lasers being studied intensively at Livermore and elsewhere. The same type of unit is now being tested for use in simulating the physics of hydrogen-bomb explosions, as well as the effects of such explosions on missile nose cones.

Hyde has also been simplifying the magnetic rocket nozzle, though he doesn't have a final design yet. Again, he has sophisticated computer programs to help him. One shows the details of how the magnetic nozzle produced by specific magnetic coils acts in response to a microexplosion. The magnetic field lines blow up like a balloon as the explosion progresses, then bulge rearward, permitting the products of the explosion to escape.

Most important for the future is Livermore's progress in building big lasers. The lab leads the world in this area, which is no small claim. Lowell Wood says, "There are three kinds of liars: liars, damn liars, and laser builders. A guy will build a laser and claim it has fantastic energy in its beam. But then you ask him, 'Can you produce the energy again, or did you do it only once and blow up your laser in the process?' The Soviets," Wood recalls, "once claimed to have the world's most powerful laser. It turned out that the report was based on a single test that burned up all the lenses. At Livermore the claims are legitimate."

And one thing is sure. When starships are built, they will be built according to Rod Hyde's basic designs. Aboard the first ships carrying humans toward the stars, his name will be a household word. ∞

IN THIS WORLD, MAN FINDS BUT FEW PRECIOUS THINGS...



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OMNI

THE ARTS

By Marjorie B. Mann

Robots are very much alive in the New York City studio of Catherine Field. Two life-size forms ignore you at the door while a cabal of mechanical masks stare sightlessly from the floor. The walls are hung with robot drawings and a large mural depicting an *automa passeggiata*, a Felliniesque street parade of homunculi. Mechanical beings in various stages of construction casually occupy worktables, bookcases and partitions. Most interesting is a "first generation" of about 25 robot sculptures, approximately 1.5 feet high. These creatures, endowed with human gestures, jump, prance and wave, mocking the more serious devices that constitute contemporary robots. Hung individually on their own stark white wall, this group, collectively forms a spiral, symbolizing its own ascent into life," says artist Field.

The structural parts of Field's sculptural robots are largely sheet metal, aluminum, colored cable wire, and screen. One sculpture is made almost entirely from sheet-metal shavings. Put together with rivets or nuts and bolts, many of the sculptures have movable parts and can take different positions, depending on the artist's mood. Other materials, composing the torso and features of these saucy characters, include computer chips, circuit boards, filters, calculators, temperature dials, numbers, springs, chains, even some crab claws.

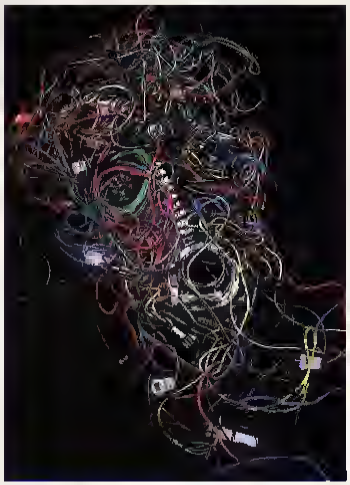
Field cites Mary Shelley's *Frankenstein* as her primary literary influence. Shelley's Romantic portrayal of the Prometheus myth inspired Field's exploration of the relationship between the creator and her defiant creation. The myth of humans stealing fire from the gods could become a reality, she says, with the continuing development of artificial intelligence.

Fernand Leger was another influence. In the Twenties, the French painter envisioned a new civilization whose core was the machine. Field's work focuses on our cultural infatuation with new technology, the computer and the proliferation of information. In an aesthetic sense, the robot becomes a starting point for her investigation of figurative form as, ironically, robotic constructions frequently are based on intensive imitation of human form.

Field finds much of her material on the street and in junk shops. In her studio it steadily grows into collections that are transformed into sculptures. Having worked on construction sites with sheet metal, she finds this medium comfortable for her. "I was influenced," she says, "by a series of servile jobs that made me consider the existence of mechanical entities. And an investigation of robot-figurative mergers became inevitable."

But enough of the word *robot*. Field prefers to call her creations "Data Dolls," explaining that even inanimate objects have a spiritual nature. The Data Dolls then, have ceremonial significance. "Sometimes I see them as part of my shamanistic dreams," she confides. The Dolls are also a "form of revenge on a one-shot manufacturing ideology."

While Field views part of contemporary culture as having elevated technology to a godlike status, her Data Dolls are representative of high-tech in its primitive mythical stage. The dolls are concerned with the creation myth of artificial man. "They are a means of recording and participating in this mechanical birth," she maintains. "But on the other hand, technology has also acquired negative mythical connotations. There are constant fears about whether we can control it. It has been prophesied since the fourteenth century that machines are destined to supplant the human race, although more immediate concern entails whether robots and machines will displace humans in the labor force."



Data Mask: to evoke the spirit of technology

Field examines robot replacement paranoia in a series of drawings. In these collages, angry robots—made from newspaper want ads and employment listings, oil-stick paints and glitter—stalk like bad dreams across a paper grid, as though they were about to take over your job.

Continuing her investigation of the mystical forces of technology, Field has completed a series of "Data Masks." One mask is composed of nearly 100 computer chips, with empty voids for its eyes and mouth; another is a nightmarish Medusa tangle of electrical wire. These masks are to be worn by humans, she says, when they address themselves to the spirit of technology. A person dons the mask and is endowed with the power of the computer just as earlier peoples put on the masks of powerful animals, lightning, and thunder and gained the animistic power of these natural forces.

Meanwhile she has also begun construction on larger robots that deal with specific sculptural concerns, stressing their formal qualities—scale, weight, mass, position in space, dimensionality—as compared with the Data Dolls, which were dominated by their subject. While Field imbues robots with mystical energies, one piece in particular speaks loudly of her view of their ultimate endurance. It is the only drawing she has done on the concept of nuclear holocaust, a portrait entitled "And We Survived." Its subjects—a robot and a cockroach.

COMPUTER CAMPS

EXPLORATIONS

By Doug Garr

The 14 students intently study their work sheets, entitled "Lo-Res Graphics Aid for the Apple II," while the instructor, Bob DuPree, switches on the computer. After he punches a few commands into its keyboard, an illustration of a spigot pouring a yellow liquid into a beer mug appears. The word BUD lights up under the picture. The students smile.

"Now this is a very professional program; you're not going to be able to do this in two weeks," warns DuPree. But he quickly adds that they should have no trouble learning how to draw primitive objects—squares, triangles, and other geometric figures—on the computer. A few minutes later, DuPree is teaching the kids how to draw a line.

"Now that I have my special random color and my special random number, what do I want to do?" DuPree asks.

"Plot," calls out a boy wearing a blue Bruce Springsteen T-shirt.

"Right," says DuPree. It isn't long before there's a rectangle on the screen, and shortly thereafter a rainbow of vibrant colors begins to pulsate through it.

It is one of those brutal summer mornings when the air is so hot and dense that it slows you down. But these kids, aged ten to seventeen, are in an air-conditioned classroom at a computer camp, which is run by Marist College, a small private school specializing in computer science. The college is located in Poughkeepsie, New York, on an idyllic 100 acres overlooking the Hudson River midway between New York City and Albany. The morning class is a sort of crash course in low-resolution color graphics. In the afternoon the kids will be in the lab, where they can put what they've learned to practical use on IBM, Commodore Pet, and TRS-80 computers.

Computer camps are now enjoying the vogue that summer tennis clinics did in the early 1970s. Since Denison Bollay, a thirty-year-old computer consultant, founded the first one near Santa Barbara in 1980, dozens of similar camps have emerged all over the country. Ohio State University has begun a program, and so has the Hill School in Pottstown, Pennsylvania. Atari has four camps, in Pennsylvania, North Carolina, Wisconsin, and southern California.

Like tennis clinics a decade ago, computer camps are becoming the vogue in summer recreation.

Though the curricula differ from camp to camp, the idea is basically the same: to expose youngsters to computer programming. At Marist, the kids learn BASIC and APL. PILOT, among other languages, is taught at Computer Camp International. Other camps offer healthy doses of FORTRAN, PASCAL, and assembly language. Six- and seven-year-olds can begin on LOGO, a language that features symbols and a "turtle" that allows kids to draw pictures. LOGO is even taught to children who haven't yet learned how to read.

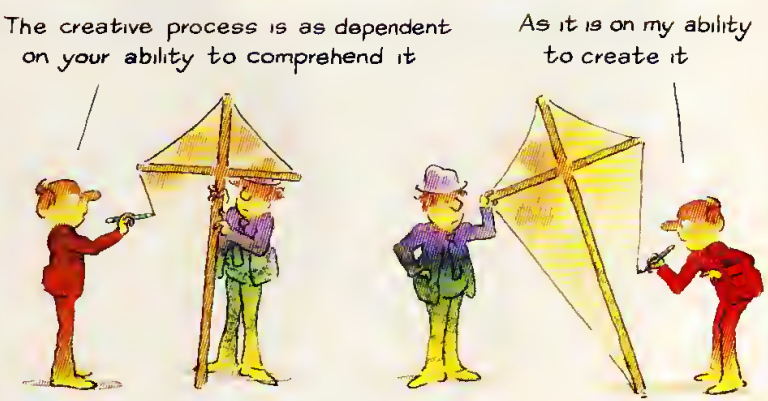
Most camps integrate three to five hours a day of classroom and hands-on instruction with the usual array of summer activities: volleyball, softball, Ping-Pong, swimming, and the apparent game of choice for young computerphiles, Ultimate Frisbee. Camp directors everywhere complain that the kids don't get enough sun and sports—they're too attached to their computer terminals. Clark Adams, the director of Computer Camp International, in Moodus, Connecticut, says the counselors have to demand that the students turn in their diskettes and jump into the pool.

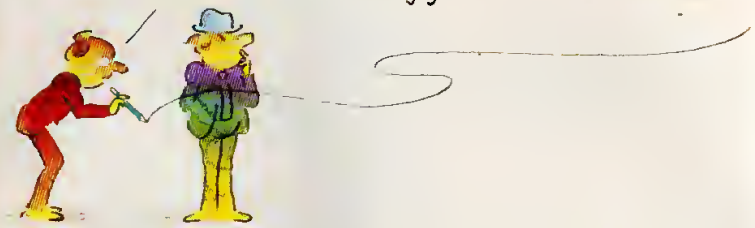
Computer camps employ a corps of two to four main teachers, computer professionals who usually teach on the college level. They're assisted by several counselors, men and women in their early twenties who are computer-science majors in college or graduate school. Camp fees are quite high, averaging around $800 for two weeks. Atari runs the longest sessions—month-long affairs that cost almost $1,600. Marist College, at $750, offers scholarships for all or part of the tuition, based on merit and need.

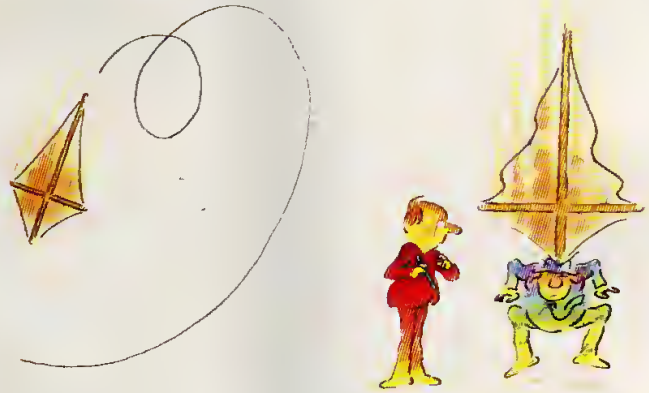
The steep price has naturally given the camps a somewhat elitist complexion. The noted French author Jean-Jacques Servan-Schreiber sent his son to computer camp, and Edson de Castro, the founder of Data General, the giant minicomputer company, sent his kids. There are few minority kids, and the boys outnumber the

CONTINUED ON PAGE 140

The Artist







BOOKS

THE ARTS

By Hans Fantel

The mood in the United States at the end of World War II was jubilant. Hitler lay vanquished, and even the uncomprehended terror let loose over Hiroshima and Nagasaki seemed to hold a bright promise: the limitless power of the atom. Like the Allied victory itself, the atom was to be the foundation of a future world peace made lasting by an inexhaustible supply of energy that would soon abolish all forms of material want.

Now, with dozens of nuclear-power plants running in the United States—two of them perilously close to New York City and Chicago—it is somewhat difficult to see our situation clearly. In his sober and meticulously documented book *The Cult of the Atom* (Simon & Schuster) Daniel Ford, formerly the executive director of the Union of Concerned Scientists, traces our path from the high hopes of the 1950s to the fearful disillusion of the 1980s.

The story told in *The Cult of the Atom* has its heroes and villains. The heroes are the people who blew the whistle, warned of dangers, pointed to faulty calculations, and urged expanded testing programs and accident simulation on small-scale models. Stephen Hanauer, a member of the Advisory Committee on Reactor Safeguards, noted in a memo in 1971 that "not a day goes by without one or more mishaps at an operating reactor," but no system was ever established to look into these problems.

The villain of the book is the Atomic Energy Commission (AEC), which repeatedly covered up for the incompetence and sloppiness of its major contractors. Since its creation by President Truman in 1946, the commission has been curiously subservient to private industry. According to Ford it has "issued licenses to build commercial nuclear plants . . . as routinely as the State Department issues passports to travelers." When scientists began to realize possible pitfalls in the design of fission reactors in the 1950s, the AEC looked the other way. Rather than address the technical problems, the commission passed legislation like the Price-Anderson Act, which limited the liability of power companies for nuclear accidents.

To anyone following Ford's account the only surprising thing about nuclear accidents is that there aren't more of them. His narrative, which amounts to an accusation of willful negligence on the part of the AEC and the Nuclear Regulatory Commission, is full of documented evidence of dangerous errors in judgment, horror stories that might even be entertaining if the subject weren't so grim. For example: we are told that the explosion of a test reactor in Idaho on January 3, 1961, was deliberately triggered by a man who suspected that his wife was sleeping with a fellow worker at the reactor. Both men were killed, along with an innocent bystander, at great risk to the environment.

In another incident at the Brown's Ferry Plant, near Decatur, Alabama, an electrician's aide, with only one day on the job, set a fire that burned for seven and a half hours, he was searching for air leaks with a lighted candle.

These are not the kind of stories that the government likes to have reported. The papers of the AEC lay buried until Ford cracked open the archives with a lawsuit brought under the Freedom of Information Act. The information clearly indicates that under prevailing conditions and policies, no nuclear-power plant is safe. What's more, with the high cost of fuels, nuclear power isn't even cheap.

It wouldn't be fair to ascribe this nuclear debacle to sheer greed, though large sums of money were at stake. The real culprit is the leniency shown by the government's supervisory agencies toward private corporations. This fateful laxness is at least partly attributable to an inappropriate idealism. But those good intentions don't make the present situation any less frightening.

So, in the fourth decade of the Atomic Age, the dream of nuclear peace and plenty has faded. Hope for cheap and safe atomic energy may have to be deferred until the time when nuclear fusion—as distinct from nuclear fission—becomes a practical power source.

The secret papers of the Atomic Energy Commission: tales of mismanagement and mishap

EXPLORATIONS

CONTINUED FROM PAGE 134

girls by about five or ten to one. By and large the campers are highly motivated, spurred on by a keen awareness of the need to become computer-literate.

Suzanne Busby, a fifth-grader, said she wanted to come because "I want to be familiar with computer languages." Her friend and fellow camper, Sybil Cafiero, also a fifth-grader, has her own Apple II. Suzanne became interested when Sybil got her machine. Sybil explained that her aunt, in her twenties, was too old for computer camp. "So I'll be able to teach her when I'm finished," Sybil said proudly.

Kelly Anson, sixteen, has already taught himself BASIC on his TRS-80. "I've written a couple of music programs," he said. "And I'm pretty sure I want to make a career in computers. But I wanted to learn how some other computers work."

Marist campers are expected to complete a term project on the computer, which can be either frivolous or serious. "But I always emphasize to the kids that this is not school," insists Dr. Lawrence Menapace, the program director. "They're supposed to have fun. There are some rules, though. No stereos or TV sets. Lights out at eleven. We do not allow packaged video games. You can play a game only if you create it yourself."

While most summer camps divide up their groups according to age, computer camps seem to bunk kids with similar computer experience together. Marist has three levels of classes: beginner, intermediate, and advanced. Computer Camp International has a five-level breakdown. At the Hill School, each week-long camp session features a specific, in-depth program (either advanced or beginner) in a given language.

Many campers already own their own computers, and while they're not encouraged to bring them along to Marist (the point is to learn how to use a machine you *don't* own, according to the director), they are welcomed at other camps. Children can be seen lugging their Apple IIs and Ataris at the beginning of a session at Computer Camp International. The computer lab here is an inadequately cooled, rickety-framed one-story wooden building. But the kids don't seem to feel uncomfortable. Their last hour of lab is "free" time, and that's when they're allowed to play Raster Blaster, Jaw Breaker, and electronic poker.

And it seems healthy to report that computer campers don't differ much from ordinary summer campers. They're constantly complaining about the awful food; they cheer delightedly when a waiter drops a plate; they call fruit drinks "bug juice"; and the boys still raid the girls' bunks after the counselors fall asleep.

But that's where the resemblance to ordinary camp ends. The instructors may wear tank tops and shorts to class, but they take their work seriously and expect the

kids to do so, too. Lenny Huber, an instructor at Computer Camp International, says, "I don't think of it in terms of summer camp. I think of it in terms of school. It's work, and they're expected to work hard."

Director Clark Adams, however, points out that the kids might even be more attentive and faster learners than their elders. "When the machine says SYNTAX ERROR, the kids know they made a mistake," Adams says. "Adults don't believe the machines. They kick the computer when they make mistakes. They act out their anxieties on the machines."

The rush to teach kids about computers may be causing at least one potential problem. Some children are under the mistaken notion that knowing how to run a piece of prepackaged software is all there is to operating a computer.

"Some of the kids are hardware-rich and imagination-poor," said David Yukol, an instructor who works for Clark Adams. "They think they can program, and they can't. I had a kid last week who told me he knew all but BASIC. He really needed a strong dose of LOGO. He didn't understand the difference between following someone else's rules and making his own. That's a whole other level. That's what computing is all about. And presumably, that's what computer camp is all about."

CAMP GUIDE

There are over two dozen computer camps in the United States, and some of the most popular include:

Marist College
c/o Dr. Lawrence Menapace
Poughkeepsie, NY 12601
914-471-3240, ext. 345

Computer Camp International
Dr. Arthur Michals, Administrative Director
310 Hartford Tpke., Suite D
Vernon, CT 06066
203-871-9227

Computer Camp Inc.
1235 Coast Village Road, Suite G
Santa Barbara, CA 93108
800-235-6965

Ohio State University Computer Camp
Office of Continuing Education
2400 Olentangy River Road
Columbus, OH 43210
614-422-8571

Compucamp
P.O. Box 20141
Santa Barbara, CA 93120
805-963-5936

The Hill School Computer Camp
c/o John E. Parnell
Pottstown, PA 19464

Atari Computer Camps
800-847-4180 DO

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CONTINUED FROM PAGE 30

video discs, providing higher fidelity in smaller packages—an area the Japanese are already investigating.

"Mass storage has been called the mother's milk of computing," says John Klonick, of Dataquest, a California consulting firm. A device that is so cheap and offers such a dramatic increase in capacity should permit wonderful things at home—from more sophisticated programs to much bigger databases for all kinds of applications.

NEW WARES, HARD AND SOFT

Sinclair, beware. Texas Instruments has come up with some competition for that inexpensive computer marketed by Timex. TI's machine also sells for less than $100 and is designed to be a powerful personal computer for beginners. The TI-99/2 has a 16-bit microprocessor and uses software on cartridges or cassettes. In addition to the typical fare—from household management to computer games—the software library includes two entries providing simple step-by-step instruction for novice computer programmers: "Learn To Program" and "Learn to Program BASIC." The new computer's 4.2K bytes (4,200 characters) of random-access memory (RAM) can be expanded to 36.2K bytes. (From Texas Instruments Inc., Box 22574, Dallas, TX 75265.)

Artificial intelligence, like the human variety, can be quirky. Sometimes eliciting specific information from a personal computer requires nothing less than a semantic argument and it may take several time-consuming attempts before the computer will respond to your command. But the Savvy system is designed to give Apple II computers a little more human understanding. The device is half-hardware, half-software. It consists of a circuit board and accompanying disks that plug into the Apple. Savvy's secret is a program that enables it to recognize arbitrary groups or patterns of about 100 words. Now, instead of composing codes to your computer, you can come right out and ask it direct, simply put questions, like "How much money do I make?" or "Can I see the inventory?" ($950 from Savvy Marketing International, 100 South Ellsworth Street, Ninth Floor, San Mateo, CA 94401.)

The Model 20 DataVoice Desk Top Communications System is an intelligent telephone, electronic mail system, and computer data terminal combined into a single unit the size of a typewriter. This "communication workstation" makes it possible to communicate by phone, review computer data, and transmit electronic memos simultaneously. Its telephone handset is perched atop a display monitor. The unit includes an electronic date book that shows the time, date, and up to 80 appointments. The DataVoice plugs into standard telephone lines ($2,495, from Basic Telecommunications Corp., 4414 East Harmony Road, Fort Collins, CO 80525.)

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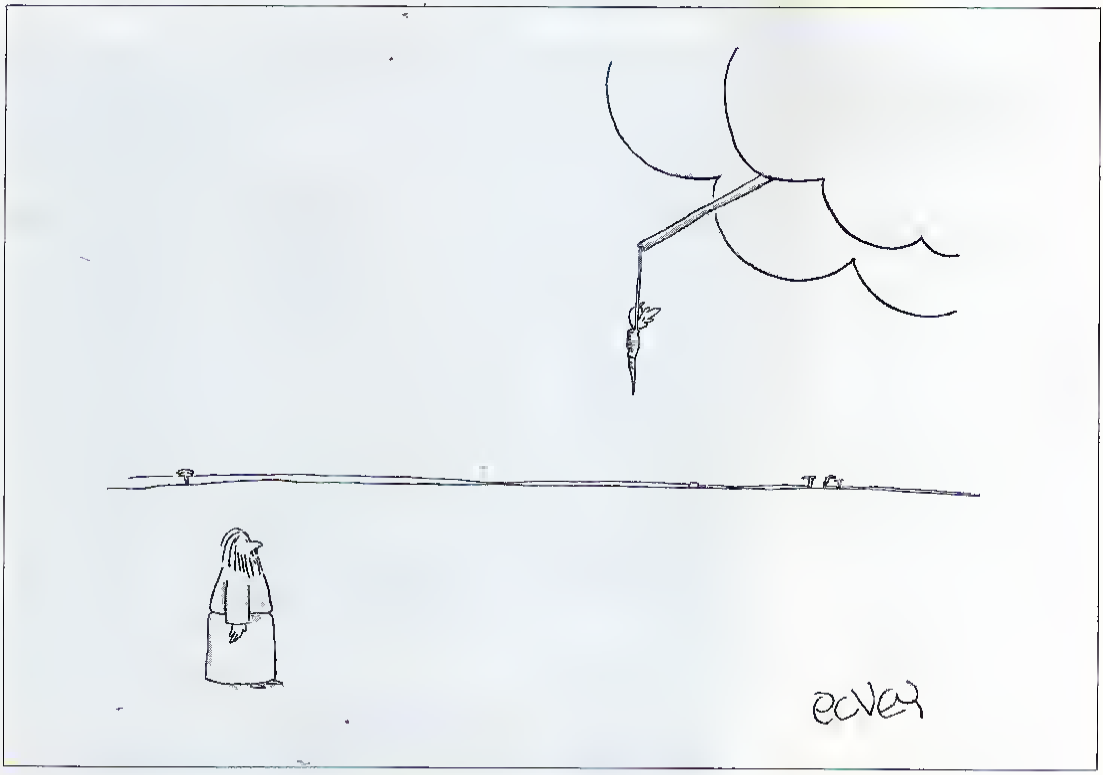

MIND

CONTINUED FROM PAGE 26

humans would characterize as thought-like. "When I first began to work with my robots," he admits, "their movements seemed so controlled, so intelligent, it looked as though they were alive, even though I knew they weren't. As we become more sophisticated at giving robots freedom to operate, their reactions will appear even more alive to us. We will begin to see a psychology behind their actions."

This perceived psychology is expected to become more rich and varied. As robots move from factories to settings where they interact more often with humans, the gradations and complexities of robo-psych will increase. With this in mind, Koto Matushima, dean of engineering at Tsukuba University, has already analyzed the behavioral differences that would exist between an industrial robot and a robot nurse. In the factory a robot would merely have to work hard to be accepted. A robot nurse, however, "would have to project an air of calm, and competence, and friendliness," he says, "or the human patient wouldn't trust it, follow its instructions, or let it care for him." To establish such a relationship, says Matushima, would be simple. The human would communicate with the robot by issuing commands, while the robot would only make requests of its human patient.

Further in the future, robot visionaries like Richard Gregory of Bristol University in England believe that differences in robot behavior may give rise to various species of robots. Different breeds will have different patterns of response depending on how they process information and the kinds of decisions they are designed to make. These robots will be as different from one another as priests, generals, and advertising executives are among humans.

Right now there are three distinct obstacles that stand in the way of building robots with psychological potential. First, powerful computers must be reduced to a small enough size to fit inside a robot's body. Second, artificial-intelligence software will have to be improved so that a computer can evaluate and act on the flow of information from its sensors, internal solving abilities, pattern-recognition systems and locomotion—all at the same time. Third, the software must also help the machine learn from its past actions. Third, the robot hardware must do more than satisfy the basic needs of locomotion and balance maintenance; it must elevate the machine's skills to a higher level of coordination to interact more freely and fully with its environment.

When will all this happen? At the rate computers are shrinking, a tiny mighty-micro powerful enough for a robot could be developed within five years or less. Already there are mobile microprocessors powerful enough to allow robots sufficient physical freedom to interact with their surroundings. And there are computer-software structures called expert systems that allow computers to process information much in the same way as human experts do: learning from past actions and storing the newly gained knowledge for future use.

Less well developed is pattern-recognition software, the key to letting a robot see the world as humans can. Still, the basic principles are already known and a few years of experimentation with video-sensor equipment on robots should produce machines that have enormously increased vision capabilities.

Robot hardware is under intense study as well. There are robot legs walking at Waseda University, in Tokyo, and at Ohio State University laboratories. Robot arms are flexing at Tokyo University and at NASA's Jet Propulsion Laboratory. Robots are already putting their primitive hardware to work in factories around the world.

As Tsukuba University's Yutaka Kanayama observes: "We are solving the mechanical problems quickly. When the computer engineers perfect their artificial intelligence systems, we will be ready to create truly intelligent robots. Then we will have true robot psychology. We are not there yet, but we are very close." ∞

COMMUNICATIONS

CONTINUED FROM PAGE 12

Mixmasters

The December 1982 Games column refers to a game called Armatron as 'Arthur C. Clarke's Waldo ... come to life.'

Unfortunately, you have mixed your masters. "Waldo" was conceived by Robert A. Heinlein, rather than the sage of Sri Lanka. It's enough to give credit to Clarke for his own remarkable ideas without stealing Heinlein's rightful thunder.

C. Kevin McCabe
Chicago

No Place for a Pessimist

I read the interview with Theodore H. White [November 1982] with great interest and I agreed with everything he said until he responded to the last question. I am outraged that a man with such insight would say something so archaic as, "In space exploration, I can't see any other nation silly enough to waste so much money on a wild idea that may not actually pay off."

I couldn't believe it. And as if that comment weren't bad enough, his next remark was inexcusable. "There won't be any colonization of space. Nobody wants to go there."

As a member of the Planetary Society, I would love to volunteer to work and live in space. I'm sure the other 111,000 members of the society would gladly join me.

Our greatest accomplishment will be the expansion into space. Anyone who reads *Omni* will agree that there are unlimited advantages in this venture. We must not give up space exploration, we must increase it.

Cheryl Glasser
Apollo, PA

I am sure that Theodore H. White knows more about politics in America than I'll ever know. But as a woman, a philanthropist and a believer in the value of space exploration, all I can say is: Thank God Mr. White only writes about the nation's politics and doesn't actually determine them.

Sharon Holland
Glastonbury, CT

UFO Abductions

The October 1982 issue contains a UFO Update [Antimatter] by Alvin Lawson in which he dismisses UFO abduction accounts as being only a kind of universal Jungian "birth trauma" memory. He falsely describes my book on the abduction phenomenon, *Missing Time*, as supporting this outlandish theory.

Lawson apparently believes that superficial resemblances here and there prove a cause-and-effect relationship. He sees the quasi-laboratory setting in most UFO abduction accounts as being a misremembered hospital obstetrics room; any kind of hallway becomes the birth canal, and so forth. Elsewhere he has taken his theory to more extreme lengths. He has written that abductees describe UFOs as circular because these witnesses actually remember themselves at the dawn of their consciousness—as little round, fertilized eggs. When the UFO occupants are described as wearing backpack-type equipment, the witness is simply recalling himself as a fetus. If you believe this, you'll believe anything.

The problems with Lawson's theory are manifold. He seizes upon hypnosis—frequently employed to retrieve abduction memories—as providing a plausible context in which birth traumas can hypothetically float into consciousness, disguised for some unexplained reason as UFO experiences. The fact is that dozens of these similarly described UFO abductions are remembered without hypnosis.

Most abduction reports have a solidly physical side. Abductees are often missed and searched for when they suddenly turn up; they often bear virtually identical physical marks. Jungian archetypes, as far as I know, do not leave scars.

To say that Lawson's theory is inadequate is not to say that someday somehow a mundane explanation for the abduction phenomenon might not appear. No one can be comfortable with the implications of these seemingly unbelievable accounts. Who would not want to wish away the terrifying notion that men and women are being used as involuntary laboratory subjects for some unknown alien purpose?

Budd Hopkins
New York

Psychic Satire

It is sometimes difficult to tell just how an article in *Omni* is intended to be taken. Usually the fiction is labeled as such, and an experienced reader expects to find oddball items in the Antimatter pages and satire on the Last Word page. But the "Psi-Q Report" by Stephan A. Schwartz and Rand De Mattei [Mind, November 1982] while apparently intended as a serious analysis of an experiment on "psychic powers," has the potential to be one of the most amusing satires you have ever published. The only thing not funny about it is that it is sadly typical of the uncritical analysis this field usually produces. After stating that statistical analysis predicts that the success rate they achieved could be expected by sheer chance at least once in sixteen trials, Schwartz and De Mattei proceed to characterize their results as "better than chance." The similar self-contradictory analysis of the "creativity test," topped off by a plea for governmental or industrial funding for research into what is clearly more a popular religious belief than a relevant scientific hypothesis, makes this report a true gem.

As a scientist (biochemist), I am concerned about the sorry state of the American public's understanding of science. I have given lectures in the philosophy of science in an attempt to educate some small part of the public which is being so poorly served by the schools and most of the popular media. I intend to cite this article in future lectures as an example of the "my mind is made up, so don't confuse me with the facts" school of pseudoscience.

Norman Hall
San Diego, CA

Praise for the Educators

I read with interest Joel Davis's article "Olympics of the Mind" [Mind, December 1982]. As an educator whose students have participated in the program since its second year, and as the person who serves on the OM organizing committee for New Jersey, I feel qualified to supplement the article with additional comments.

Dr. Gourley and Micklus, the program's originators, have served education, particularly gifted children's education, well. No program is perfect, however, and several of OM's aspects require clarification. Mr. Davis's article implies, and OM officials tend to foster the impression, that the activity is most appropriately geared to students already identified for formal programs for the talented and gifted (TAG).

My experience demonstrates that this is not the case. We have always opened participation to anyone who wished to take part. As a result, in addition to a high participation rate, we have sent winning teams made up of average and learning-disabled students to the national tournament.

A second clarification concerns the statement that problems offered are varied to suit the participants' ages. This is not always so.

For example, one of this year's problems required students to read sections of *The Odyssey* and rewrite them in a humorous vein. There was some concern over the appropriateness of some sections of *The Odyssey* for younger students. By using inappropriate material, the OM invites criticism and undermines an otherwise worthwhile activity.

In summary, I have written this letter to salute two educators who have developed a solid vehicle to tap students' creative talents that schools and society often ignore in this era of fiscal restraint.

Robert Ginsberg
Coordinator/Supervisor
Programs for the Gifted and Talented
East Brunswick, NJ

Is It Alive?

In their article "Hidden Monsters" [January 1983], Karen Ehrlich and E. Lee Spiegel quote my estimate of the size of "Champ, the infamous monster of Lake Champlain." Details of the calculation, based on estimates of the length of the waves near Champ, will appear in the first issue of the *Journal of Cryptozoology*. As to the contention that these waves indicate that Champ was alive, however, I must confess that I do not possess the ability to discern between the animate and inanimate from wave patterns alone.

Paul H. LeBlond
Vancouver, B.C., Canada

EXPAND THE FRONTIERS OF SCIENCE

JOIN OMNI MAGAZINE IN MARCH OF DIMES WALKAMERICA '83 SUNDAY, APRIL 24

Every step you take in a 30 kilometer walk brings us closer to discovering the causes of birth defects... Walk in New York, New Jersey or Connecticut and raise money with every kilometer you complete.

To register call: (212) 922-1460 or your local March of Dimes Chapter.

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NEXT OMNI

FICTION

Robert Silverberg, a regular *Omni* contributor, has lived in the San Francisco Bay area for many years. In "Amanda and the Alien," he has achieved the perfect characterization of a certain type of Californian. The striking thing is that this nasty little story was written before "Valley girl" became a familiar term to most Americans. Our other offering, "Vengeance is Yours," marks Pat Cadigan's first appearance in *Omni*. Cadigan, who in real life writes greeting cards for Hallmark, lets her venom out in this cautionary tale aimed at the slick, predatory barflies we all know so well.

INTERVIEW

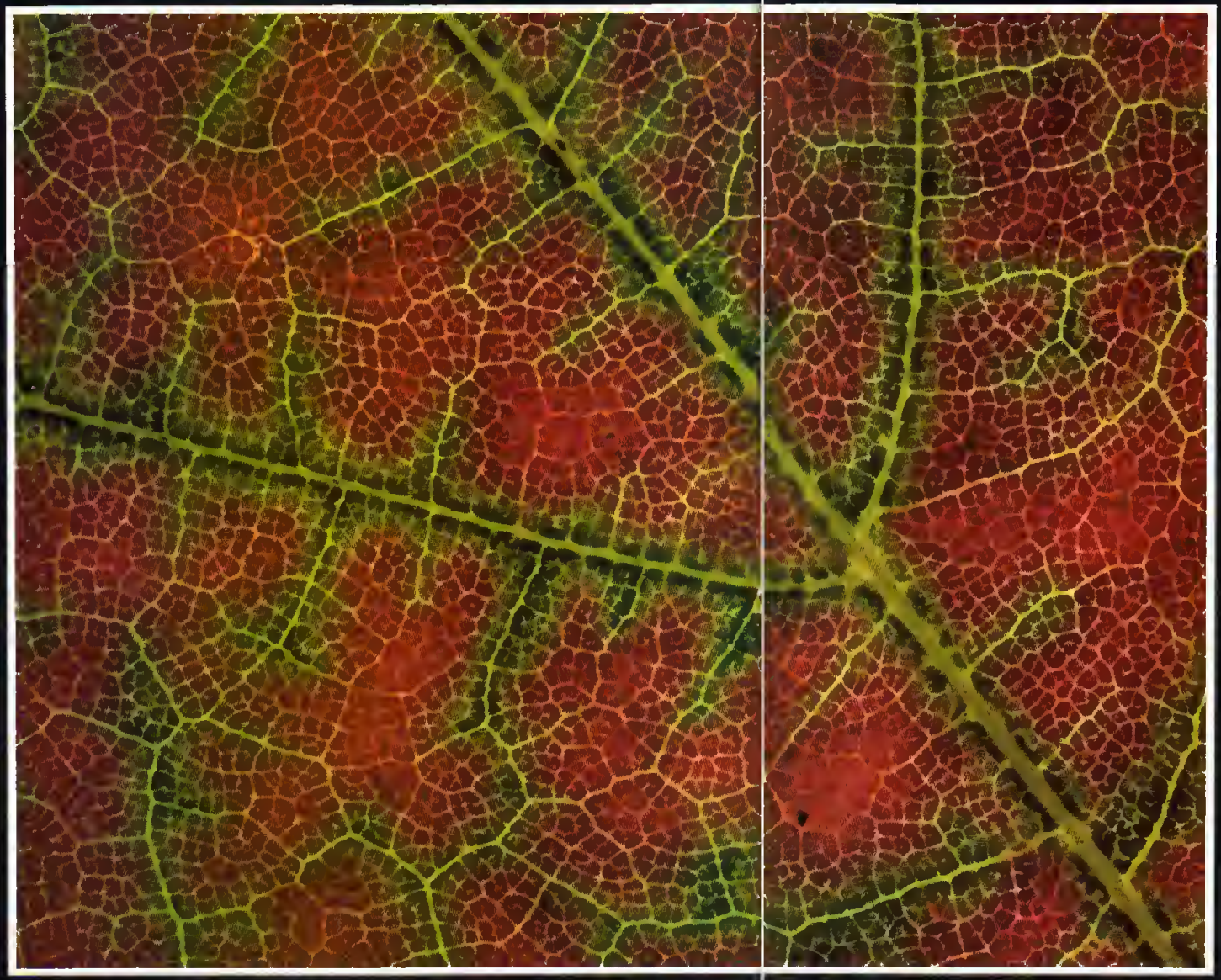
To Ilya Prigogine time is the forgotten dimension, and he has directed his life toward an understanding of its role in the universe. The Belgian chemist was awarded the Nobel Prize for his theory of "dissipative structures," which describes the workings of open systems—chemical reactions, cities, ecosystems—maintained by flows of energy so intense that the system reorganizes again and again, never returning to its previous state. This irreversibility is the heart of positive growth and change. Find out in the next issue of *Omni* why nothing stands still for Ilya Prigogine.

ATOMIC NIGHTMARE

The test shot that detonated on the Nevada range in the predawn of March 24, 1953, seemed different to sheep rancher Kern Bulloch. The ground shook eerily. The sheep were more frenzied. The mushroom cloud soared, fiery and turbulent, to 40,000 feet. What Bulloch did not realize was that he was becoming an unwitting principal in a tragedy that would span three decades, with echoes sounding in Hollywood, Washington, D.C., and throughout the land. "The Day We Bombed Utah" is not only the harrowing saga of how the AEC's nuclear-testing program shattered hundreds of lives in two rustic Utah towns; it is also a timely exposé of our government's inadequate nuclear-safety standards. Best-selling suspense writer John G. Fuller has crafted a story that brings the tragic lessons of Hiroshima and Nagasaki into our nation's heartland. See the May issue of *Omni* for his heart-rending account of this major government coverup that has endured to this day.

BAROQUE FANTASIES

The paintings of Donald Roller Wilson, notes one art critic, conjure up a "Kurt Vonnegut-like world of plausible improbability." Wilson's pictures are starkly realistic in detail, yet completely unworldly in content, featuring disembodied legs, primates dressed up in baroque costumery, and chain-smoking cats. The characters and props that fill his canvas could have come straight from a haunted house, which probably explains why his work has attracted such collectors as Steven Spielberg, Harrison Ford, and Carrie Fisher. Don't miss Wilson's droll images in the next *Omni*.



PHENOMENA

An ordinary maple leaf becomes a mosaic of reds and greens veined with an electric pattern of light. Photographer R. Hamilton Smith made this portrait as part of his lifelong fascination with the world of macrophotography and the new worlds and dimensions it opens up to him. "I like to get inside something and photograph it so that it appears to be totally new and allows the imagination to play," he explains. He attempts to work against the literal style of nature photography, what he calls the "what-is-this" attitude that expects nothing more than a simple copy of the original. Instead he works an eyelash distance away from his subjects, exploring new perspectives, like this abstract of color and shape. Hamilton took this macroportrait by attaching a reversing ring to a Nikkor 55mm lens and placing it on a Nikon F2A camera. The photo was recorded on Kodachrome 64 film. ◻◻

THE COSMIC SERPENT

STARS

By Patrick Moore

Comets are very much in the news these days. For one thing, Halley's Comet is on its way back and it should have much to tell us. For another, an astounding new comet theory has been proposed by two highly respected astronomers at the Royal Observatory in Edinburgh, Victor Clube and Bill Napier. They believe that the earth periodically goes through epochs of heavy cometary bombardment and that during one of these periods a spectacular comet, which they call the Cosmic Serpent, swung by. Many of our mythical fears and superstitions about comets as omens of disaster, they claim, can be traced to it.

Astronomers generally have supposed that comets come from the Oort Cloud, a comet reservoir located about one light-year from the sun. (It was named after the Dutch astronomer Jan Oort, who first suggested its existence.) When a comet in the cloud is perturbed—by the gravitational tug of massive Jupiter, for example—it moves toward the center of the solar system. And each time a comet passes perihelion, the point in its orbit closest to the sun, some of the ice in its nucleus evaporates and the comet diminishes slightly in size. As a result comets are short-lived on a cosmic scale, with life spans of a few million years.

It has also been assumed that comets are genuine members of the solar system and have remained in the Oort Cloud for billions of years. Clube and Napier, however, think differently. They theorize that the original comets of the Oort Cloud have long been depleted and that the supply is replenished when the sun periodically passes through one of the spiral arms of our galaxy. For the next few million years after such a pass, the supply of comets is plentiful and comet activity is particularly high.

Also, when comets die, say Clube and Napier, they become Apollo-type asteroids—that is, small bodies that follow orbits different from the larger, regular asteroids restricted to the region between Mars and Jupiter. One such object, Hephaistos, was discovered in 1979. It is estimated to be about six miles in diameter and moves in an orbit similar to that of Encke's Comet. It also has much the same orbit as that of the Beta Taurid meteors, and some time ago Harvard astronomer Fred W. Whipple suggested that all of them—Hephaistos, Encke, and the Beta Taurids—were the result of a breakup of a larger body some time back in the third millennium B.C.

Astronomers now believe that these Apollo-type objects can sometimes collide with Earth. In fact, one such collision may have occurred 65 million years ago, perhaps causing the abrupt extinction of the dinosaurs.

With all this in mind, Clube and Napier turn to the near-present and look at comets in mythology and history. Men have always been afraid of comets, and the two astronomers suggest there may have been a historical basis for this. They suggest that in near-historical times a very large comet, the Cosmic Serpent, was forced into an Apollo-type orbit.

It would have made close approaches to the earth periodically and would have been brighter than a full moon. More important, it would have been accompanied by debris hitting the earth, making natural disasters more likely.

In time the Serpent faded from view, and the meteors decreased. The period of disastrous impacts passed—for a while. And what happened to the Cosmic Serpent? Clube and Napier think that it became what we now call Hephaistos, a dark remnant of its former self.

That, in brief, is the theory. It is revolutionary and unorthodox, but it is being taken very seriously as an honest effort to link astronomy with archaeology, paleontology, geology, history, and even mythology. And if Clube and Napier are correct, at the moment we are at a fairly safe period in astronomical history, and the chance of a major Apollo-object strike is small. Eventually, however, the sun will again traverse one of the galaxy's spiral arms; the Oort Cloud will be replenished, and there could be more Cosmic Serpents. When the next one appears, the results should be spectacular, to say the least.

A comet primeval. If two astronomers are right, the supercomets of prehistory may return

Campfire logic, fast knots, and other miracles

GAMES

By Scot Morris

'Beaten paths are for beaten men'
—Eric Johnston

This month we present a potpourri of perplexities and head-scratchers. Solve them by applying logic, general information, insight, cunning, or quizmanship, and avoid beaten paths. Some items require a serious working through—others will reward deviousness.

A score of ten or above is excellent, eight or nine is good, five to seven is fair, if you score four or below you're either too intelligent or too stupid to be taking tests like this—take your pick.

1. CAPITAL LETTER (Geography). There is only one state in the United States that shares no letters with its own capital. Name the city and state.

2. CAPITAL LETTER (Logology). A certain six-letter word changes its pronunciation when it is capitalized. Its initial letter is *p*. What's the word?

3. ANYTHING IN COMMON? What, if anything, do the following have in common: the location of clocks in a casino and of public telephones at a racetrack; rat vomit; a mayfly's diet; and books by Isaac Asimov that have reached the best seller list before his current *Foundation's Edge*?

4. TROUNCE. In a regulation nine-inning baseball game the home team scores two runs in each inning and the visitors score one run each inning. What is the final score of the game?

5. STREET SCENE. Why are manhole covers circular rather than square?

6. PRIME CUT. Why would a barber in Paris rather cut the hair of two Italians than one American?

7. STRANGE DRIVE. How could you head your car north on a straight road, drive for a hundred yards, and find yourself a hundred yards south of where you started?

8. RHYMING CLASSIC. This riddle, one of the world's oldest, is still good for starting arguments. A man is looking at a portrait. 'Whose picture is that?' someone asks, and the man replies, '*Brothers and sisters have I none, but that man's father is my father's son.*' Whose picture is the man looking at?

9. TIMELY. What occurs once in a second, once in a month, once in a century, but not at all in a week or a year?

10. TRIALOG. 'Feldman owns more than five hundred video games,' says Anne.

"Oh, no. Feldman owns fewer video games than that," says Bruce.

"One thing's for sure," says Carson. 'Feldman owns at least one video game."

If only one statement is true, how many video games does Feldman own?

11. OUTSTANDING IN THEIR FIELD. Two goats are grazing in a meadow. One is facing due north and the other is facing due south. How can they see each other without turning around?

12. MARATHON MAN. Alfred can jog counterclockwise around Central Park in 90 minutes. When he jogs clockwise along the same route, it takes him an hour and a half. Why the difference?

13. ELEVATOR. This question and the next are classic campfire logic problems. They work best when you present the puzzle and have other people ask yes-or-no questions until they get the answer.

A man lives on the twentieth floor of a high-rise apartment building. Every weekday morning he gets in the elevator, rides to the ground floor, and goes to work. Every weekday evening he enters the elevator and, if there is another passenger, rides to the twentieth floor. If he's alone, however, he gets off at the sixteenth floor and climbs four flights of stairs to his apartment. What is the reason for his behavior?

14. JUSTICE. A man is tried for the crime of murder and found guilty. The judge says, 'This is the strangest case I have ever seen. By all the evidence you are guilty beyond a reasonable doubt, yet the law requires that I set you free.'

What is the reason for the judge's decision?

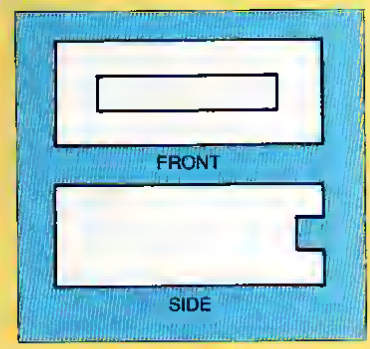
15. TALLYING TOAST. Today, April 1, 1983, I have nothing important to do, so I decide to total the number of breakfasts I have had since the beginning of the year. That's 31 days in January, 28 in February, 31 in March, plus one in April makes a total of 91 breakfasts.

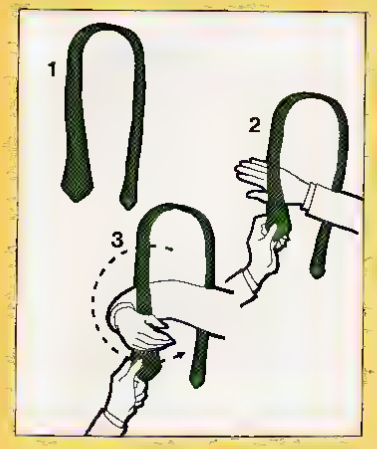
How many breakfasts would I have had if this had been a leap year?

16. LOONY QUESTION. The moon takes 27 322 days to go around the earth. Last night I saw the moon rise at 7. Tonight it came up at 7:04. I was in the same spot on both nights. The year is 1983. What is today's date?

17. TWO VIEWS. Shown below are two different perspectives of the same three-dimensional object—one from the front and one from the side. What is the simplest three-dimensional shape that would produce these views? Sketch it.

Answers to Numbers 16 and 17 will appear next month. No tricks—they can both be solved—though they may seem beyond reason. All other answers may be found on page 120.





TIE ONE ON

This do-as-I-do challenge is not a trick. What makes it a nice April Fools' stunt is the extreme difficulty most people will have in duplicating your childishly simple actions.

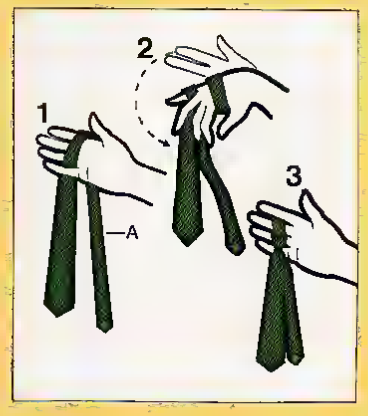
Place a necktie flat on a table as shown above (1). Seat your spectator on the other side of the table and ask him or her to watch carefully. Describe the steps as you perform them slowly and deliberately. "Lay the tie on the table like this: big end on the left, little end on the right (1). Pick up the big end with your *left* hand, then reach under with your *right* hand (2). Cross *over* the tie with your right hand, pick up the other end (3), and tie a knot in it." Follow these steps as illustrated, separate your hands, and there will be a knot in the tie.

Most people have a very hard time repeating this simple action, especially if they have viewed it from across the table. When they try to cross *over* with the right hand (step 3), they move the hand directly across—forward and to the right—which, of course, yields no knot. You can often demonstrate the move several times, and spectators still may be unable to repeat it.

Tips: In step 2, move your right hand forward, palm down, and pause at that point so people can clearly see how the move starts. In step 3 you move your hand *backward, palm up*, briefly, which is the opposite of the suggestion you planted in step 2. Most people won't notice the important difference.

TIE TWO: In a fancy men's clothing store, a salesman may try to show you how a necktie will look with a knot in it by literally and laboriously tying a knot for your inspection. The Amazing Randi preys on such people in order to demonstrate his original "necktie-salesman's move," in which he knots a tie with one quick flick of the wrist. Hold the tie as shown below, left, with the larger end draped over your right hand, your little finger in front. Concentrate on point A (on the small end of the tie) and the pincer formed by your index and middle fingers. In a sudden move, reach forward and down to grab point A between these two fingers (2). Snap the tie off your wrist and hold it up by the loop (3).

Tips: Think of the trick as three separate motions: first *down* to grasp point A, then up to pull A through the loop, and finishing with a *downward* flourish to tighten the knot. "Monsieur, your tie wiz zee knot in it."



COMPETITION #28: VIDEO GAMES

Tired of *Frogger*, *Fast Food* and *Communist Mutants from Outer Space*? You won't have to wait long for these.

**Deadline! Finish your copy by the date circled on the calendar, but not before. Deal with emergencies as they arise: the "pencil-needs-sharpening" buzzer, the "out-of-coffee" alarm and the "what's-on-TV" diversion. At random intervals you get paid on time and earn bonus points.

**Laundromat: Get as many clothes done in the shortest time for the least money. Washing machines and dryers become available at one- and two-minute intervals, on average, a dryer can hold 1.5 washer loads. Dry more than that and the towels and jeans will need to go in for part of another cycle. Penalties for putting whites with colored fabrics, using the wrong temperature, adding softener in the wrong cycle, or running out of quarters and having to go to the newsstand and buy something.

**Pack Man: How long can you last as manager of the New York Yankees? The object is to boost ticket sales by any means possible. Do beer commercials, make a fool of yourself kicking dirt on umpires, call press conferences, or win baseball games. If ticket sales go down—pack man.

**Valley Girl: Object: Throw a bitchin' party, meet guys that are tubular to the max, and clean up before your parents get back from Palm Springs. And don't get gagged by the spoons.

**Video Game: Put out a virtual replica of someone else's video game and make as much money as you can before you are hit with a restraining order.

Send us your proposal, on a card, for a next generation video game, 100 words maximum. Our grand prize winner will receive $100, runners up (two through nine) will receive $25 each. All entries become the property of *Omni*, none will be returned. Send entry, postmarked by May 15, to *Omni* Competition #28, 909 Third Avenue, New York, NY 10022.

LAST WORD

By Randy Cohen

"Perhaps they've already replaced your modular sofa with five sofa-robots. I'd be careful where I sat if I were you. They are among us."

Every emerging technology, from steam power to genetic engineering, has provoked anxious rumors. And as robots become increasingly common, they too will inspire frenzied speculation. To help you get the jump on robot hysteria, here are ten impending robot rumors:

• A national hamburger chain is entirely owned and operated by McRobots. It began when a few experimental models were brought into the business: fry-droids, grill-tomatons, and rib-robots. By shrewdly investing their tip money according to a financial strategy plotted by their friends (computers at a prominent brokerage house), the robots managed to engineer an unfriendly corporate takeover. Who knows what they'll add to the special sauce? Will they start serving McDiodes? Will Ronald McDonald eventually be automated out of a job and forced into early retirement at the Old Clowns' Home?

• A certain Olympic team is packed with robot ringers. (I can't name the country; there are spies everywhere. I don't even trust my toaster.) Let's just say that there's an Eastern European nation to whom Olympic gold is very, very important. (That's what happens when a country has no worthwhile rock bands, movie stars, or twelve-year-old fashion models—they care who wins the hammer throw or the luge.) The country in question has been censured in the past for dosing its teams with forbidden drugs and for entering athletes of dubious gender in the women's events. But that's Bronze-Age cheating compared to what's on-line. For the Los Angeles games in '84, the judges will have to determine which entrants are human and which are not. To put it another way, get ready for the four-second mile, the fifty ton bench press, and the L.A. to Paris pole vault.

• George Steinbrenner will replace the entire New York Yankee infield with android athletes. For a man who experiences such profound pride of ownership feelings, it's a dream come true. No longer need he pretend to treat his players like human beings. If his new robot pitcher fails to perform, Steinbrenner can do something more dramatic than trading the bum to Texas. He can have him broken up and sold for scrap. The only people who are likely to fight the shift to automation are the players' union and the chewing-tobacco lobby.

• Robots engage in bizarre sex acts. They like to keep appliances as pets and do kinky things to them. (That's why I couldn't discuss the Olympics in front of my toaster. It could be having an affair with some robot, and anything could be blurted out in a moment of digital ecstasy.) The appliance departments of certain stores, it has been learned, function as after-hours clubs for robot roués, catering to every sort of grotesque automated lechery. Jaded human jet-setters have even been frequenting these robot bordellos, seeking high-tech thrills.

• Lassie? The dog never did its own stunts, everyone knows that. Mr. Ed? His real name is Mr. Edelstein. He changed it when he went into show business, becoming the first Jewish horse to have his own prime time sit-com. Similar is-he or-isn't-she speculation will be central to celebrity robot rumors, as stars buy robot stand-ins to handle their public appearances. This will add zest to *The Merv Griffin Show* as viewers try to figure which, if any, of Merv's nightly guests are actually human beings. Liza Minnelli? Zsa Zsa Gabor? Charo?

• Certain powerful congressmen are secretly serving robot interests. They must they've accepted enormous campaign contributions from Robot PACs. Robot influence even extends beyond Congress to the Oval Office. When you are a machine, you don't care if they call catsup a vegetable, for that matter you don't care if they call iron ore fruit. It's all the same to you, as long as you can get your batteries recharged when you please.

• It was not actually Howard Hughes hiding out in that Las Vegas hotel suite all those years. The true story is that Hughes had a robot recluse built to his specifications. All that time, the real Howard Hughes was hiding out in a hotel suite in Reno.

• There are Iranian robot hit squads roaming the country, gunning for Nancy Reagan's clothing designers. That's why she buys so many clothes—to throw the killers off the scent. That way they won't know who to shoot first.

• There are Soviet robot disinformation teams disguised as computers at major American newspapers. Their mission: to discredit Jerzy Kosinski.

• Finally, the coming robot rumors will exploit our fear that the machines are among us. Scientists are nowhere near building a robot that can mimic the complex behavior of a human being, or even the clumsy actions of someone like my Uncle Milt. But the truth is they aren't even trying. Rather than developing simplified versions of people, government researchers are creating sophisticated versions of furniture, exploiting the inroads made by Magic Fingers and the Barcalounger. All they have to do is add some input-output devices, install an on-board computer, and devise a mobility system. And there it is: the digital bed, the intelligent walking coffee table. In fact, perhaps they've already replaced your modular sofa with five sofa-robots. I'd be careful where I sat if I were you. They *are* among us. It's like that famous SF movie *Invasion of the Sofa Snatchers*. At least that's the rumor. ∞