HARNESS THE WIND: KITE POWER!

MARCH 1994

SPECIAL! BIG BANG EXPLAINED

WEIND WEATHER LIGHTNING STRIKES AN HURRICANE PATROLS

BILLY IDOL GOES INTERACTIVE STARTLING SCIENCE FICTION BY JONATHAN CARROLL





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Fooling with Mother Nature may not be ruce, revertheless, the horizon harbors some defense signish the nasty side, Join us in the age-old battle between humans and their environment. (Cover at by Julin Zuckerman, additional crodits, page 84) FEATURES

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FIRST WORD

WRITING OFF AFRICA:

As the world reorganizes, one continent gets left behind

By Randall Baker

ou may be torgiven for thinking that Africa is the utfmale hopeless place indeed, there is a strong place bifly that the West is in the process of writing off Africa

Early visitors were impressed by what they saw in Africa a university in Timbuktu, the art of Benin, the emporiums of the Sahara,

Educated In Ugandia and author of Environmental Man agement in the Tropics: An Historical Perspective, Randall Baker is a professor al Indiana University's School of Public and Environmental Environmental the castles of Gon-But 250 years of slavery domolished the social order that is a precondition for art. trade (other than slavery), and agriculture to flourish At the end of this ppriod, when Europe no longer needed slaves but feared growing imperial competition among the emergent European nation states.

Africa was rapidly, thoroughly, and grotesquely "enclosed," suffering the earlier fate of the common lands of Europe.

Thus, the chaos induced by the slave trade was somehow transformed into an excuse for "salvation and modernization."

In short order, Europe established meaningless "states" bonded by a foreign language, compilely distorted agriculture in favor of luxury export crops, displaced nulgenous religions, pourd contempt on ethnoscence, and torbade any form of political expression. In these orounstances, is it surprising that Africa is seen as hopokess, stagnant, or regreesing?

There is now a pervasive sense of hopelessness about Atnca. It supplies about 4 percent of world track, it has scarcely benefited from the Green Revolution that ignored Atrica's besic staple, millet, it has at least 6 million peopie who are infected with the AIDS wrue, it has received billions of aid dollars with dismally poor results, it is an environmental mess, and it is heavily in debt. As the continent finally made the concessions to democracy demanded by the West, the West's interests shifted dramatically to Eastern Europe's democratiza-

But, the picture

both, the precent set to get over worse Europe. Africa, is currently preoccupied with Russia and Eastern Europe, and Germarojative it recently adopted The United States may be ropositioning toward Latin America and Asia. In additon, the spread of

fundamentalist islam and the bardening attrude of Europe to North African immigrants may well place a wall of hostile states between Europe and Black Africa, effectively isolating the polar global power struggle. Africa has little or no strategic importance that could draw attention to fise!

While this all looks rather hopeless, an answer may come only from a racical response to this traumatic situation. First, the contipant has to be won back from its dustinctional history. In the late 1950s, Ghana's Nkrumah called for Pan-Africanism to unify Africa. give it a significant voice in the world, overcome its Balkanized and culturally absurd political divisions, and lend some economic clout through larger, more open markets. He was put out of business with the aid of the West Instead, the Organization of African Unity (OAU) declared the colonial houndaries to be sacrosanct. The new states then went in for a curious, and spurious, exercise known as "nation building," Why any African in virtually any of the new states should leel any allegiance to the boundanes imposed in Berlin is unfathomable. The traditional and historical identity-with the tribe or clan-is unmentionable since it is an herefical affront to "nation building " But those social heresies are the only truly indigenous things Africans have left

Perhans what is needed is something akin to the nonthreatening superstructure of the European Community to take the heat off the phony "nation state" without eliminating it overright. It could allow intra- and interstate reolone to floursh as they are now doing in the EC. Economic security and growth may help counter Africa's demographic explosion This may seem like romantic nonsense indeed, but that would have been the reaction of the establishment to a 1950s suggestion by Jean Monnel, French statesman and father of the European Community, that an economically united Germany and France share a common vision common institutions, and open borders. The European Community broke an historical mold

So why not an Attican Commusity? After all, everything allow earers to have been trick, and cutside one or two bright stars (Botawana with its that/state comicidence), nothing seems to former, and only the midgeneration of Entree, and might hint of Samalland, flustrates that Artice OUUs savettistation of contraits boundance. With the European unon and NAFTA now realities, may be Artices now needs to revisit Pan-Articearies DO



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THE CORPORATION

Retaud M. Outon (prepairier vip. measure), Witten F. Markel (president marketing, page and provident marketing, (execution of p. C.F.O.), Patrix Devine (execution of C.F.O.), Patrix Devine (execution of C.F.O.),

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EDITORIAL

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AUVERTISING AND MAPNET INS

ADMINISTRATION.

BEADERS' WRITES

Visions of a collective consciousness, online government, and the impending energy crisis

Collective Beast

"Souts in Silicon" by Frederik Pohl and Hans Moravec [November 1993] was very interesting. However, what I find more interesting is what happens after we interface the human mind with computers. Such a person will not only have greatly enhanced personal abfities, but carried a step further, that individual could communicate on such a level and speed with other peoplepeople also interfaced with computersthat they could create a single awareness that would be far greater than the sum of its parts, just as we humans have a single awareness now that is made up of all of our single cells.

James C. Burns E Paso TX

Checks and Balances

In response to December's Political Science column, I must say that long before the predicted December 1, 1999. dateline for the dissolution of the federal povernment, our telecommunications networking and computer technolpoy and software will have advanced to a point at which an online computer model of the federal government's total economical workings will be accessible over the phone lines to anybody with a modern. The biggest complaint about having a central American government is that it allows unbelievable waste and abuses of the budget. But with the online model available to virtually anybody, everyone can see if the emperor has no clothes and then dead stop the waste and missilocation of tax money quickly.

Bob Schreib, Jr. Toms Biver, NJ

Energy Equation

Before we jump back on the nuclear bandwagon (First Word, December 1993], a fundamental question needs to be answered. Are nuclear-power plants actually net moducers of enercv? That is, when you add up the energy necessary to mine and process fuel, build the plant, operate the plant, cisnose of the waste, and so on it is guite likely to come out to be more energy than the plant produces in its lifetime. What has made the nuclear inclusity economically viable in this country is huge government subsidies. If they had to make it on their own on the basis of net anaray produced. Ike renewable-energy industries, they would probably

Dr Ralph G Bell Marshall TX

Any publicat-fission reactor built will. over several decades, eventually become too radioactive or too unreliable to operate safely. The only future for all nuclear-nower plants is on-site entomb ment. The world's most famous entombed reactor at Chernobyl sets a horrifving precedent. Its "coffin" is already failing agent and leaking, and it's been barely a decade

Christopher Magee, Jr. Los Angeles, CA

Nuclear power is indeed one of the most environmentally benign sources of energy. Reynolds is correct in that we have an electricity hungry world. The Department of Energy estimates that by the year 2010; this nation alone will need the equivalent of 130 more large nuclear-power plants. Efficiency improvements come first, but they will be insulficient, and thus we must move ahead to provide energy facilities that will take us into the next century.

Theodore M. Besmann, Ph.D. Research Group Leader. **Oak Ridge National Laboratory** Oak Ridge, TNDO

Got something to say but no time to write? Call (900) 285-5483. Your comments will be recorded and may annear in an uncoming issue of Omni. The cost for the call 18 95 cents per minute. You must be age 18 or older. Touch-tone phones only, Sponsored by Pure Entertainment, P.O. Box 166, Hollywood, California 90078.

FUNDS

THE TAX MAN COMETH: Audit proofing your 1993 return

By Linda Marsa

sometime this year, an estmated 1 million Americans will receive that dreaded letter from Unole Sam moforming them lihi ther it ax return is being audited—an experience one taxpayer (Ronad to getting a heart attack in the mail. But there's plenty tapayers can do to control the damage and avoid marv headaches.

The good news: The IRS is so understatified that it audits less than 1 percent of individual taxpayers. The not-sogood news: The number of returns audited jumps dramatically for those earning more than \$100,000. many headaches. What prompts the IRS computer to spew out your income tax return for a close ar look are too many incomsistencies in your statement Most returns are selected for an audit based on the IRS's Discriminant Function System (DIF), which assigns a numerical score to key dems on your roturn, like adjustments to income, exemptions, and deductions, all based upon national norms.

What raises red flags are, say, medical costs that exceed the standard averages or business expenses that are so high it doesn't leave you with enough money to flive on. The higher the score, the more likely your return with

be pulled, The parameters of the DIF formula are a more closely guarded socret than the plans for Star Wars, but you can get some idea of what the averages are for people in your income bracket by consulting the U.S. Master Tax Guide, available at most libraries.

The IRS also routinely largets a number of items for scrutiny. This year, the rules are much alifar for deductions for home officee—once a ruly way of writing off your den—and for claiming costs for your computer, now it must be required by your employer and used al least half the time for business. Your kids can't be playing Nitherdo on it 24 hours a day, Uncle Sam also casts a dubious eye on border/the business expenses such as deducting travel costs to a finend's out-of-town wedding because you buttonholed everyone at the affait about your widgets. And Con gress is closing the loopholes that allowed chiseters and downight chapts to squeeze through the cracks an the system and

avoid reporting more than \$100 billion a year in income.

"The IRS looks for at least three good audit issues. Otherwise, it's a waste of their hour." says Mary L. Sprouse, author of How to Survive a Tax Audit "So if you exceed the DIF in five areas then it would be worth calling vou in " Sprouse, a Los Angeles tax attorney and former Internal Revenue Service audit manager who has worked both sides of the tence, believes the best defensive manager is to keep good records so you can justify expenditures "An audit is solely about proof," says Sprouse "If you cannot prove an expense, then

you're not really entitled to it."

If you do get called in, don't partic Although tax and penalties on audited returns averaged \$5,812 in 1992, 16 percent of taxpayers emerged from these ordeals unecathed. So find out in advance what items are being questioned so you can narrow the scope of their search. When you go to the IRS office, bring records

for those areas only That way the agent won't be tempted to go on a "fishing expedition." Or you can send your tax preparer down to the IRS office to plead your case.

"If you have all your records, there's no reason why you shouldn't go by yourself." advises Sprouse. "But if you fudged and didn't document, or if there is a tricky item on your return you simply don't understand, then you need an advocate." And even it you do represent vourself and end up botching eventhing you can suspend the interview at any time and send in a pro to straighten out the mess

There is, however, one type of audit that's impossible to saleguard against-the Taxpay or Compliance Measurement Program (TCMP), better known as God's Nightmare Every three years, about 50,000 unlucky tax nevers are randomly selected to participate in this program. which is designed to collect data to establish the DIE benchmarks for normal patterns of income, expenditures, and deductions, if you're chosen for a TCMP audit, be prepared to justify every single tem on your return and just look upon it as penance for all the comes you've committedor even thought about committing-in this lifetime CO

SOUNDS

INTERACTIVE IDOL: Don't call it cyberpunk rock; video fusion may be an evolutionary step

By Wayne Yacco

eady for swarm cams and fusion stations? Jay Leno took to them in a Torught Show minute when they were introduced by Billy Idol on a small-acteen appearance last year. In fact, Leno temporanly became an interactive-video artist along with Idol, director Brett Leonard, and members of the San Francisco-based Digital Media Reality Lab. The team "flew" (their term) a new cybernetic instrument for the first time on national television that night. First-time swarm pilot Leno even improvised by scanning himself into Idol's gigantic wall of video as the rocker played "White Wedding "

g with Brett Leonard Reality Lab ate immusisaational jazz for the eves. as musical age attempts to mirror

The complex instrument sprawling across Leno's stage that night saw its genesis at the Micrografx Chill Cook-off during the 1992 Fall Comdex computer and Dinital Media show in Las Venas, it's also been flown at the Verburn Digital Be-In during Winter MacWorld and at several rave clubs, all in San Francisco Its components: a fusion station, swarm cams, and a matrix of monitors.

The fusion station itself consists of a large array of computer

OWNI

image processors, from a fully tricked-out \$10,000 Amiga 4000based Video Toaster to a Sticon Graphics workstation like those Leonard used to render images for his movie Lawrynower Mari

Video fusion interactively combines five images captured by fiving swarm cams with video clips. generation of realtime computer graphics, and previously rendered objects. They are multiplied in various mandalaic forms and modified with digital effects such as trails, color shifts, digital delays, and other elements. On the Tonight Show; Digital Media founder Dan Mapes mixed a wide variety of elements at a piano-style keyboard-connected to the system through MIDI-very much in the way sound samples are played on a synthesizer. "You've got digital video and graphics, either on hard disk or in BAM, that you can tripper rapidly with a keyboard and bring visual icons and symbols in that match the feeling or the sound of the music or the content of the lyrins " he explains.

Today, this live, interactive, digtal-video art is displayed and parformed like a combination of psychedelic light show and modern dance-on stage and in a pixel space. In the future, it will be performed in the voxel space of virtual reality. You will even be able to create it on a machine small enough to fit on your desktop The systems used on the August 12 broadcast of the Tonight Show however, filled a stage and cost well over \$100.000

As the input to this system, the Sharo LCD swarm cams are almost a byproduct, but their operators add an getie dreamlike dance element, orbiting the object of their focus with the movements of a digitally inspired Isadora Duncan. The term "swarm cam" is derived from, and aptiv-

invokes images of, cameras swarming like bees. It was coined at Digital Media to describe the use of large numbers. of prosumer video cameras connected to the fusion station "Three is the smallest swarm carn you can have," says Leonard, who directed the swarm came and choreographed them with the NBC studio cameras. 'There should be at least ten-fourteen for a fullblown stage," he suggests

"This whole thing is a cybernetic art machine," says Mapes, "Just like an airplane takes a crew to fly it, this thing takes a crew." That's Idol's view, too. "I see it as something that illuminates what my music's all about," he says "And, in fact, it aliows me to put a lot of my daily life into the fusion, as I'm one of the swarm-cam team as well." Manes claims that "old art is aimed mostly at people's eggs. For those of us who come out of the digital culture, this is more like a live flow. It's the first art form that really mirrors a deeper level of consciousness

Leonard, who also recently directed Idol's metamorphic "Shock to the System" video as well as Peter Gabriel's no less transformational "Kiss That Frog" video and simulation-ride film, calls the cybernetic art machine "a fusion of different people from different disciplines with the medium itself and the tools." It's not just a dimmick. "This whole thing comes out of Billy playing with the concepts that philosophically were in link with the concepts that a group of us were playing with namely, this swarm-cam-fusion thing, which is an amakaam of many different sonstutities. The fusion is completely symmetrical and reflected throughout the entire structure of the piece." The Idol crew already likens it to a group mind DO

ONNI ONLINE

YOUR TWO CENTS' WORTH: The results of Omni Online's interactive surveys

By Byron Poole

ver been pried from the dinner table and onto the telephone to respond to a questionnaire-or a marketing scheme disquised as one? You probably know something about how presumptuous, leading, and obtuse such "surveys" can be. A recent cartoon comes to mind, in which a man with a phone held out in one hand says to his wife, "It's a polister, honey. Do we feel A) substantially, B) overwhelmingly, or C) totally betrayed by the president?" Slanted and inconsistent cuestioning leaves one warv of poil results and the interviewer

of point relations and the interviewer at the other units of the interviewer We say the black of communications at the more the beasity of the interviewer model as its potential to do just that. When you cick to do just that. When you cick to do just that. When you cick to communications on the Omri Onime oppring science, you can all caders' auroup, "Your Two Cansa' Worth" is our way of getthat up in Chem and of measuring your perspective on current social sessel

After the first survey was posted, we readly took advantage of Ornin Online's electronic nature, inviting comment as well as survey responses. Our online reades added a new dimension to the traditional questionnaire Taxy sent E-mail informing us of what, exactly, they would change about the survey.

We Issaned and did some inkering to make our survey more informative. And once again, our readers spoke out, telling us they appreciated the improvements, impressed by the withigness of our readers to voice their interviewer-interviewed delogue concerns, we deciside to take the interviewer-interviewed delogue of the survey a stop further. The bweekly survey now has its own



message board, in which the results are posted and readers can discuss both the questions themseives and the issues raised

Our Science and the Soul issue (October 1993) certainly inspred a deluge of reader mail. From fundamentalist to atheist, voices wanted to be heard.

"Are the mind and body separate things?" resulted in an exactly 50-50 yes/no ratio-the only time such a perfect split has occurrent for us. From here, we wanted to know if, in your opinion, science would ever be able to offer an "explanation" of consciousness Of the respondents, 61.4 percent believed that, indeed, science would one day get it figured out. A slighter majority, 56.8 percent, think a computer will one day develop consciousness. (We got such a stir of letters, both electropic and on paper, from this question, that we explored it even further in the "Souls in Sticon" survey the following month.) Finally. a whopping 84.1 percent said they suspect that humans are not the only animal in possession of conscio isness.

'Finding God in the Three-

Pound Universe," also from our fifteenth-anniversary edition raised the delicate issues of relinious ecstasy and psychedelic drugs. First off, we asked where you believe the gateway to the transcendental experience originates. The majority of you, 64.9 percent, responded that the brain, rather than the soul, is the gateway Next, we wanted to know if a drug-induced transcenciental experience should be considered a valid religious experience. The navs took that one by a small majority, although a sizable majority believes the government should help fund research on potentially therapeutic hallucinogenic drugs

A steady stream of survey questions and results have followed with equally brow-raising outcomes, Janet Stites's "Bordercrossings. A Conversation in Cybersnape" (November 1993) kindiad the debate on the divide in Western culture between science and the arts. Also from the November issue were questions raised by Pohi and Moravec in "Souls in Silicon," such as if transferring the human mind to a computer man synhution. And the Decemher issue offered a rine selection of material, from the ominous potental of special effects to the predictability of the future (If the future could be accurately predicted. 59.4 percent believe it could still be changed)

We like to think of the results from these surveys as catalysts for darter probing rather than as one in themselves. How is 1, for example, that 49 percent of the people polied think they works to able to experience emotions if their personalities were transferred to a computer, but then ontheir personalities were transferred to a computer, but then y 39 percent works stations, cuestions. **DO**

anno's proversion electronic survey lakes the interviewee relationship a step further and comes up with some curious results.

THE GERMS OF SCHIZOPHRENIA Abnormal fingerprints may point to origins of mental disease

By Kathleen McAuliffe

ichael Lee first saw the signs of schizophrenia in his identical twin in their late teens. Out of the blue. Malcolm began hallucinating that he was Prince Charles. even accusing their mother of kidnapoing him at birth from Queen Elizabeth The diagnosis of Malcolm's condition brought further havoc to the family. Fearing the disease might be hereditary. Michael was formented by the possibility that he would follow his twin's descent into madness. His mother had it even worse. "Not only did Malcolm walk around glaring at her malevolently." says Michael, now 31, "but the psychiatrist blamed har for his sickness."

Bad genes, bad parenting and other theories have been put forward to explain the baffling symptoms of schizophrenia, a disorder debiftating some 2 million people in the United States alone. And for every schizophrenic. there is a confused and devastated family. But the Lee twins have provided an invaluable clue to solving schizophrenia's mystery. As participants in a study by Stefan Bracha, a child/ adolescent psychiatrist and researcher at the University of Arkansas Medical School, they gins and possible prevention of the disease. What's more, the findings from the investigation of twins hold promise of increased understanding of other perplexing neurological syndromes

Recently, many expents have tavorde a hereditary explanation of schizophrenia, offing studies showng that if an dentoidal twin has tho disease, the other has a 50 percent chance of being afficited But as Malcolim and Michael's cese fluctrates, environmental factors play a noise, too. But which one? If Bracha is right, the insitquarting factor is not uncaring, manipulative parents, or other famly trauma. Rather, the chief suspects are prenatal insults—such as viral infoctions—that may damage the fetal brain, setting the stage for the development of actizophrenia later in fife.

Bracha uncovered key evidence for his theory using a standand tool of police detective workthe fingerpant kit. Although iconoclastic for medicine, his approach has a rationale. Fingers, he explains, form in the fetus just as the cerebral cortex is undergoing peak development in the second trimester. Any agent herroing the felus at that stage, Bracha reasons, would also leave its damaging mark on the fingers. To test his hypothesis, he turned to identical twins in which one of the pair was healthy and the other sick. In addition to the Lee twins, 22 similar pairs volunteered for the study. Sure enough, onethird of these twins were found to have fewer ridges in their fingerprints and smaller than normal finder tips. Moreover, these subtle defects only occurred in the schlzophrenic, never in the healthy twin. "The correlation between schizophrenic and abnormal fingers was highly significant," Bracha reports "That's very suggestive of a second-trimester insult."

Purther bolistering his theory, ho notes that several Scandnavan studies have Inked a particullarly vindent strain of influenza A with schizophrema in the offagring of moders who contracted it during the second immatter Damage to the feat bran. Fractus hopsame to alcohel or krugs anemas in the models, or from a aveated umbiboal cord that reduces coygen flow to core twin.

To E Fuller Torrey, senior psychietrist at St. Etzabeth's Hospital in Washington, DC, Bracha's theory makes sense. Many studses have shown that solizophrenics are statedially more likely to be born in the spring or late writer, Torrey observes. "That kind of seasonality implies something might be happening before or around birth." Torrey himself has long suspected a virus might be involved. "By drawing our attention to the in utero period," he adds, "Stefan Bracha deserves a lot of credit."

Bracha would fike to see the government invest in more programs arried at providing prena"It we could get pregnant women treated for anemia, drog abuse, and other risk tactors," psychiatrist



tal care. Meanwhile, he is broadening his study to include children suffering from dyslexia and hyperactivity. Once again, he will compare the finger morpholony of healthy and afflicted twins to see if prenatal insults might be contributing factors to these peurobiological disturbances. A better understanding of how these disorders arise will not nonessarly translate into improved treatments But to Michael Lee, that in no way diminishes the importance of Pracha's inquiny. "Whether he finds a cure or not." Lee points out "we're all better off if society becomes more knowledge able about the underlying causes of these coorditions. You can deal with them much more rationally " DO

Stetan Bracha says, "it might be possible to prevent schizophrenia in some children at risk,"

EARTH

HURRICANE OMNI: Scenario for seeding an imaginary storm

By Carl Posey

The most promising appreach to altering humcares now, as a genertion ago, tes on huming the humneame is own power against flexit The objective would almost containly be to intercode—perings frough cloud seeding—in the netural processes that cause the eye to expand and contract end to reform at greater distances from the center there, dream from conver1,000 and 10,000 feet, before, cluring, and after seeding.

The four seeder alrcratt-Gulstream IV jets-carry radar and lidar equipment and cloud physics instrumentation similar to that on the Orions, permitting them to pinpoint the powerful updrafts hidden in the eye wall and primary rainband-updrafts with an abundance of supercooled water the scientists hope can pump



Hurricane Andrew pounded Florida with mighty winds, stacking up yachts and pleasure boats (above); Hugo hit Saint Croix in 1989 (right).



sations with hurricane vaterans, is the way such an experiment might unfold.

Reaching maturity about 900 nautical miles west of Puerto Rico, the storm is predicted to remain at sea for at least 24 hours. Humcane-hunter aircraft muster at Roosevelt Roads, the military field from which they attacked hurricane Debbie in 1969. The two NOAA WP-3D Orions are on hand, both carrying state-of-theart instrumentation that includes lidars (the laser equivalent of radar) and microwave Doppler radar, which parmits them to monitor fine threa-dimensional motions of water particles in the storm. They'll fly low-level missions for eight hours, at altitudes between additional heat into the storm clouds, arresting the humcane's development when it has expanded to a broader eve.

Crysthead, two geostationary satelline have been placed over the equator, 30 degrees apart, gwng scientistis stores views of the storm to detect charges in situature aiter seeding. The entre experiment is controlled rom a forward headquaters, through the Global Positioning System, St., once degloyed, the aircraft will need an subnormy that matchas the vanability of the furritaria

Well before dawn on the first seeding day, one of the Orions takes off into the lightening sky east of Puerto Rico, taking several hours to reach the hurricane,

which it enters along the spifel rainbands, tying only 1,000 feet off the churring sea. For the next 72 hours, the human will shave have one of the Onons in it for fen hours at a stretch—back-breaking flying for the crews but necessary to monitor the storm and, it possible, to delect the human signal caused by seeding.

"The Guildtreams take off near midday, climbing to a multing altitude above 40,000 test. Ywo of the Guilstreams stay high and fly some dislance from the tringes of the storm, gampling the altimopheric environment for subtle disturbances that could introduce a false signal into the humcame The other two fly up the rainbends just above the freezing level at about 25 000 foet.

As the lead Gulfstream plows into the hard wall of rising cumulus cloud along the primary rainband, its raders tell the scientists aboard where the best seeding will be and vector the aircraft toward those turrets in the primary reinband. Once inside the hard, wing-wrenching wall of rising cumulus towers, the Gulfstream laws down a nlume of smoke rich in silver rodide, spewed from whomounted hurners. It bucks through the eye wall into the calm, sun-filled center of the storm then returns along the rainband, seeding it again. The secand seeding Gulfstream builts into the same area and spews its plumes of silver-lodide smoke. When they've expended their silver-iodide supply, they climb out and return to Puerto Rico for fuel and a fresh crew.

No one knows, going in, whether our imaginary hurricane will turn toward shore or the northern Atlantic with a larger eye and diminished winds. Like Debbre in 1969, it is an experiment, but untike Debble, it could be a beginring, not an end. DO

MUSEUMS

THE COMPUTER MUSEUM: From calculation engines to PCs on Beantown's waterfront

By Frederic Paul

n a Boston wharf, sandwiched between a lobster shack and a giant milk bottle, sits a unique demonstration of the seductive power of the PC. Stroll through the Computer Museum's amazing 50-timesscale welk-through computer that actually works, and enter Tools & Tres: The Amazing Personal Computer, a \$1 million exhibit where you can ride through virtual reality, shoot a commercial starring yoursell, make multimodia music, play unique games, and even create personalized sou-



Dedicated to documenting and displaying he artifacts of the Information Age, the Computer Museum also demonstrates and teaches.



venirs-all in about an hour,

Tools & Toys uses standard hardware-aid donated-and spocial adaptations of existing commercial software along with spocial custom applications to show that "computing can be fun, even if you've never done it before," says Oliver Strimpel, the musium's executive director.

The exhibit "was definitely geared to young children and famfiles," agrees cohibit director David Greschler, "but it ended up appealing to power users and poople in the computer industry" as well. With seven distinct environments housing more than 35 stations, "the breacth of the exhibit pulls them in," he says:

"The environments include Mating Pictures, Writing, Making Sounds, Adding II Up, Exploring Information, Pisying Gamos, and Sharing Ideas. The key to the project's success is that imstead of watching statute demo programs, watching statute demo programs, watching statute demo programs, watching statute demo programs, enters, "asys Greechtor, "The centpertence is the message."

One of the most popular athletis is Be Your Own Band, which combines a MIDI (Muscal Instrument Digital information) and the board, and dount past to let vitinos create their own muscal compositions. You can lay your own racks over rook, funk, classical, or salas backgrounds to create multilayered instrumentals. A Macinosh controls the tempo, nich, and vourme.

Another station, called the Virtual Reality Chair, exemplifies the PC's ability to create whole new worlds The station offers a swivelchair voyage through an imaginary landscape, complete with virtual mountaine, a virtual house. and even a virtual dog that barks if you come too close. The first and still one of the few permanent virtual-reality exhibits in the world the Virtual Reality Chair is a unique compromise between the simplicity of computerdame simulations and the complex high-powered requirements of full-scale virtual reality

The SampleStick shows how computers can match disparate elements to build something new. Visitors use a joyalick to composinew music from digitized samples of prerecorded compositions, just as rap DLJ's use sampled sounds to create new hits. A remarkably hip selection includes bits from many of the leading rock and pop stars of the last half century.

The individual stations are onby part of the story, however The sweaping curves of hrighly colored waits, supergraphics, and glass bricks make the oxhibit look like a computer playground, claims exhibit designer Ted Groves "The playground feeling comes from the fact that most or what you see on the screens nicluding the colors—goes on the waits, goes in the paint."

Toole & Toyle began in the early 1880s as the branchild of Boston Computer Society lounder Jonakane Retenberg, and BCS voltateers pixyed a big rote in programming many of the exhibit stations. Funding was supplied by a who'swho list of PC Juminaries, Including BII Gastes, Steve Woznak, Mitch Kapor (the Kapor Family Foundation), Apple Computer, Dif-Tal Equipment, and many others

This Computer Museum spont sprinnthe testing each station in its exhibit lab., looking for bugs and making use people "got II". Many stations were changed during the evaluation people" got III Greuchice. To make sure the exhibit appoald of the time of audience, the museum asked a group of eight grates from Boohand Man as a strategistration work of the stations exciling and challengma.

With about 25,000 square text of exhibition space, the Computat Museum receives some 20,000 visitos annually. Founded in 1982 as a nonportil institution for collecting artifacts of the Computer Age, it has since oxpanded into an entertaining, hieractive, and constantly growing learning, center that charts the evolution, technology, and applcate of computers. **OO**

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DIGS

BRONZE AGE BURIAL SITES: Learning how the Mycenaeans lived by examining how they died

By Mary Ann Tawasha

rom the first archaeological dig in Crete by Arthur Evans at the ancient city of Knossos in 1900 to last summer's excavation on a hillside behind the village of Mochlos on the island of Mochlos, archaeologists have unearthed ums, utensils, and even complete Cretan villages. By examining these shards and artifacts. If ev now know a lot about the lives of people who lived in Crete during the Bronze Age, a period that spanned from 3000 to 1200 B.C. As a result of the latest international dig, some light has been shed on the mystery of the burial retuals of the Mycenseans laid to

rest in Creten hillsdes Codirected by Jeffrey Soles, in archaoologist and head of the classical studies department at the University of Neth Carolina at Greensboro (UNG6), and Costas Davaras, director of Antiquities in Eastern Crete, the international team excavated seven chamber tombs in a cometery that chaise

÷

Remains of the day: a 3,000year-old pottery vessel teond in a Mycenaean tomb (above), a lidded sarcophagus with lour vessels and a stirrup jar (right), and a terra-cetta coffin (below),



VERT

from about 1370 to 1200 B.C

According to Andrew Smith, trench master of the dig, they first had to remove small stories that several ae minute interferent to this total. These treat and the minute distribution of the control, they found the antiance to the chember-haptacardly wallow chember-haptacardly wallow the rocks Alter they removed the mode to the antiance to the chember-haptacardly wallow chember-haptacardly wallow the rocks of water they removed the mode to the antiance to the chember distribution of the control, they do not the antiance to the chember distribution of the control of the co

Historians have speculated that Bonze Age graves were actually opened when other family members died Last summer's excavation provided evidence to support the nuclear-family burial theory Saveral of the tombs contained two members, a male and a female

"When there were two burials. the first burial was laid out and the tomb closed Later. it was reopened and the first burial was displaced within the tomb to make room for the second burial. Soles says "In one chamber, I found that the bones of the earlier burial had been broken up and placed into a pyxis, a large round vase with a hd." Mycenaeans were usually buried in a sarcophagus, a terra cotta coffin Sometimes the bones were stored in a pithos, a clay storage iar, or a pyxis

The largest temb, number 13, was about five feel high: Inside, the excavators discovered & sar cophague that contained the skddata remains of a burial and a large pyxis decorated in a checkered pattern A rhyta, a ritual vase used for pouring fibations or of the other vessels; it was the last artifact placed in the tomb.

Two ritual vases were shaped

like pomegranates-a "particularly unusual find," Soles says From the sixth century B.C. on, the pomegranate was significant because it was often a gift for the dead. "It was a symbol of rebirth," he says. The archaeolonists also discovered stemmed drinking poblets (kylikes), which indicate that the survivors shared a ritual meal before burnal. Other gifts to the departed included stimun lars (closed vessels with a spout and two handles in the shape of a stirrup), tugs kraters (mixing bowls), drinking cups, and jawelry in one of the tombs, Soles says, they found a bronze bowl that contained a gold signet ring, a bronze dress pin, and a necklace made of 50 tiny beads in the shape of an ivy leaf with a large gold boad in the center. "To find so many artifacts and vessels intact was amazing, Smith sava

Judging from the initicate artwork on the pottery. Soles thinks the Mycenaceans who inhibited this satistement on Celew were high y skilled people. "They seemed to be remarkably prosperous, although not weathy," he remarks "They were probably everyday people, local land owners who itaded with the western part of Creps and the Greek mainland."

With each excavation on the islands scattered about the Aggean, we learn more and more about the people we now know as the Mypenapans-how these traders lived and how they ded. There are still as many as 70 tombs to excavate on Mochlos alone. Soles says. This summer, be and Davatas plan to open another 15 to 20 tombs. "We hope to be able to distinguish the dilferent statuses and roles of the whole occulation." he says Ironically, we get closer to the Mycenagans' fives by examining how they dealt with death DO

ELECTRONIC UNIVERSE

THE FINAL FRONTIER: New multimedia packages put the space back in cyberspace

By Gregg Keizer

e can't all'ride à rockdr trito space, cruise interstellar void, or even claim à close encounter di lind. Thero's a quota for these kinds of things, you know. Only the best and the bightnest got to climb on board the Shuttib, and only the Leise get to spot a danc-



White some CO-ROM tiles offer a ride on the space shuttle or glimpses of planets, UFO provides a database with more than 1,200 ctose encounters from counters from ing light in the sky and say they've seen a UFO

Vicanous though the virtual coperience may be, however, anyone with a CD-ROM-eculpoidd PC-and in some cases, a Macintosh--can get a taste of space-These guides four software titles don't give the feeling of some sofid rocket boosters at your back, but then you don't risk space sideness either

The Software Toolworks' Space



Shuttle, a CD-ROM disc for the PC, ranks as one of the best exoursions for space fans. Unlike a simulator. Space Shuttle doesn't let you run the complex spacecraft, but instead walks you through training, takes you up on 53 different missions, and shows you how the crew lives and works Because it's on CD-ROM Scace Shuttle is heavily narrated and includes minimovies of launches, landings, and mission elements. When you ask if to tell you about crew meals, for instance, you listen to descriptions and watch a short video of heating dehydrated food and eating with magnetic utonsils

it's at its most interesting (and ortunational) when you fly one of the more than 50 STS missions. Pick STS-49, for example, and you watch as three astronauts wrastle the intelsat telecommunications satelfite into the cargo bay Messions include everything from the first orbital test of Columbis to the January 1992 launch of Endeevor, although those dedicated to the Department of Defense don't include any in-space activity for you to monitor. Even the disastrous Challenger mission is part of the mix.

For a decidedly different experience with space, try Software Marketing's UFO: The Planet's Most Crymplete Guyde to Close Encounters. Essentially a database of more than 1,200 encounter incidents, L/FO lets you search by several criteria, including cattle mutifations, abductions, and pavchic phanomena. It then displays the sightings on a world map, shows photographs taken at the scene, and in more than 20 cases, runs short video clips purporting to show unidentified fiving oblects in motion. Like Space Shut-Ite, UFO plays on a PC from a CD-BOM disc.

If you're already a believer,

this package will only strengthen your faith, but don't expect UFO to turn a skeptic into a disciple. The inclusion of the now-debunked crop circles in Great Britain and the oddball cattle multilations in the United States take UFO to the Impe

You're on safer scientific around when you pop Time Warner Interactive Group's Murmurs of Earth in your Macintosh or PC CD-BOM drive. This eclectic two-disc collection includes all the images, greetings, diagrams, and songs that were packed onto gold-plated phonographs and bundled aboard both of the Vovager spacecraft. You can listen to the greetings and the musicincluding Louis Armstrong's "Meiancholy Blues" and a Navajo chant-on a standard audio CD player. To view the 116 images that Carl Sagan and others selected back in 1977, though, you'll need your computer Just what you'll wonder, would an alien race make of the shot of birthing a baby?

Of more general interest is The View from Earth, another CD from Time Warner that works with either a multimedia-ready PC or on a Macintosh. This talking Time-Life book doesn't play moving pictures (too bad) but combines more than 600 sharp photographs and color illustrations. with several hours of narration and music. You take tours through sections about the sun, the moon, Earth, and the other planets. There's nothing too deep here, so The View from Earth makes a good pick for the family that's interested in science.

Whether you're exploring on your own or as part of an electronic guided tour, the joy of titles flice these liss in the traveling Getting there—when there is somewhere you'd never reach in reality—is all the fun. DO

ANIMALS

A BROBDINGNAGIAN RODENT Amblyrhiza inundata was one of the bloggest ever

By Patrick Huydhe

be phrase "island magic" is more than travelindustry hype. Naturalists have long noted that animals tend to evolve significantly smaller or larger bodies on islands. But the tremendous size of an extinct rodent found in cave deposits on the slands of Anguilla and Saint Martin opes fat beyond what solentists normally have in mind "It's unbelievable," sava Ross

MacPhee, curator of mammals at

the American Museum of Natural

were absolutely

humondous ro-

dents. The largest

ones may have

been the size of

a large brown

hear" This gigan-

tic rodent, known

as Amblythiza in-

undata, "is a real puzzle," contin-

ues MacPhee

"Its size breaks all

kinds of ecolog-

ical rules. We

know that selec-

tion Dressures can

produce strange

effects-miniaturiz-

Holy cow!-or mid we say mdant. This size of a History in New York City. "These

hrows hearroamed the es of Anguilla and Saint Martin 100,000 years ago. ing elephants and hippos on Mediterranean islands, creating giant flightless birds in Madagascar. and so on--but there is no precing nearly as big as they did in Anguilla and Saint Martin

Though its remains were first discovered more than a century app, no one has known exactly how large the rodent was since no complete skeleton of the animai has ever been found. But now MacPhee and his colleagues, anatomis! Audrone Biknevicius at Ohio University and biologist Donald McFarlane at Claremont-McKenns College, have developed rigorous estimates of the rodent's size, making the

best of a paltry collection of available bane tragments. By measur ing the cross-sectional area of the animal's leg bones and comparing these with the leg bones of living rodents and other mammals of known body weight, the scientists have determined that while the smallest specimens of Amblwhize were equal in body mass to the largest living rodent, the 100-pound capybara of South America, the largest of the species were as much as four times that size.

Amblyrhiza's existence first came to light in 1868 when a phosphate manufacturer in Philadeiphia sent Edward Cope, the renowned nineteenth-century paleantologist, a block of phosphatic ore from Anguilla in which the heast's bones and teeth were embedded. Cope identified the remains as those of a rodent-its dephilion and law structure were unmistakable-and then eyed a few iong bone fragments to estimate that the animal was comparable in size to a Virginia deer. He also noted that some individuals. were considerably smaller and proposed that there had once been several species of Amblythiza

This size variation, startling in itself, was confirmed by MacPhee and his colleagues with an analvsis of the animal's incisor teeth. but they doubt that such tiny islands could have simultaneously supported more than one species of grant rodent. Instead, the size variation may represent a dilference in the sexes-despite the fact that living rodents show a mare 2- to 4-percent difference in size by sex-or a variation over fime Since most of the rodent's remains were collected haphazardly and no chronology is available for them, it isn't known whether or not the two sizes existed at the same time

Equally puzzling is how these

creatures ever managed to inhabit these islands more than 100,000 years ago. "We know essentially nothing about how it got there " notes MacPhee. "bacause its nearest relative is found in Puerto Rico and is very much smallthat it reached Anguila by rating on mats of vegetation and falled trees, lit's a convenient story, but there's no evidence for that

Nor is there much evidence for the widespread belief that the giant rodent coexisted with and fell prey to the original native West Inckans This belief rests ontirely on the existence of a shell scraper, clearly an Indian tobl. which was collected in a cave along with the remains of the rodent. But as Cope himself cautiously noted, there was no stratigraphic information to suggest that the tool was contemporaneous with the radent fassils. Indeed, in the past 125 years, no archaeological site suggestive of human presence on these islands has ever yielded a single Amblwhiza bone

"I tend to believe these things were extinct by the time people not there about three thousand years ago." says MacPhee What probably happened is that this animal did exectly what its species name-inundata-sugpests, which is that it drowned There were two or three times in the last 125,000 years when rapdly rising sea levels could have overtaken it and resulted in its complete extinction."

And so ends the story of the largest rodent ever Well, not cuite. The "largest rodent" honors notes MacPhee, actually go to Telicomys, an extinct minoceros-sized creature that roamed South America more than a million years ago "There's far more to biology than what we see represented today," he says DO

OTHER GAMES MAY TALK. THIS ONE HAS A VOICE.

Star Trek: The Next Generation's PATRICK STEWART

LANDS OF LORE: The Throne of Chaos

With Patrick Stewart as the voice of King Rschard, Lords of Lore has a royal advantage over

other fantasy games: An actor of real authority in a role of authority, at the head of a huge cast of



heroes and villains who speak, rant and roar their way through the most vocally interac-



tive role-playing adventure yet devised. (A mammoth 130 MB of digitized speech makes it possible.) The Dark Army is on the move, led by the shapeshifting socceress Scotta—and each time you meet her she'll be more powerful and terrifying than the last. But your powers can grow, too Experienced-based character development makes great warriors of those who take arms (in real time combait against as ea of indexcibable monsters).



and makes mighty wizards of those who cast Larger-Than-Life spells. Explore ancient castles, living

forests, hidden lairs, bustling towns, haunted

caverns, through 30 enchanted levels made vividly real by more than 20 MB of compressed art and special effects.





STYLE

FROM OUTER SPACE TO YOU: Turning NASA research into a comfy chair

By Nina L. Diamond

It may look strange, but Brian Park's Flogiston Chair premises unparalfeted comfort for reading, meditation, or just sitting around—plus, it's seal of approval. when brian V. Park set recliming data so he could meditate in certifort. He had no idea it might end up being used by astronuus to simulate microgravity. But it's accually rathrithing the fark's sleet. "Rogistion Chair" should find its way to NASA, because it was NASA research that inspired him in the first place

The first chair to duplicate the neutral body posture, the natural position a body assumes in weightless space. Park's chair mmmizes internal and external physical stress so that "all the muscular forces are in balance; the body is in biomechanical equilibrium. he says Back in 1980, Park, then an oil-industry design engineer just wanted to achieve nirvana without getting wet. "I tus position wasn't exactly optimum." he laughs "You end up focusing on the pain in your leas instead of meditating." Floating in water-used by NASA for microgravity training-seemed the only way at the time to keep the body stress free

Then, flipping through an issue of MASA Tech Briefs he noticed drawings of the neutral body posture. That was the "Ahal" he'd been looking for. While designing his chair. Park took advantage of the voluminous NASA research available to the public, reviewing Skylab studies on body posture. consulting with engineers at the Johnson Space Center, and Incorporating ideas from NASA's Anthronomorphic Source Book, an exhaustive three-volume study of the human body's size, shape, and motion characteristics used by the designers of the astronauts' workstations.

in 1981, Park built his prototype chair with a plywood frame and sat in it for eight years won-



dering what it was for." His grigistate that include's long-memory foam similar to the foam used in the space shuttle's seats, covered by fabric or leather. The chair can be in a fixed position. rockable, or suspended from the ceffing, comes in two standard sizes; and can also be custom fit. It's tapered, wider at the feet than the head, and "makes you nomendicular to gravity," he explains. "Your behind and your back are at 30 degrees up, your shoulders are at normal rest. your elbows are bent, and your knees are level with your chest."

Sounds cid, but Park reminds us that "when you lie in this chair, you're in a posture the body toxes to be in Everyone has a nutrit posture, but we can ony experience at floating in water and partially when were on our sole in a semiffel posture. After a floating in water a floating in water a floating in the posture of the a tev menutes in a completely neutral posture you lose awareness of the body because it's in balance "the prosture is evenly distributed and there are no hard contact points"

Park received a utility patent on the Flogiston Chair in late 1992 and formed his Austin, Texas-based Flogiston Corporation lo market i för difbe and homa. Every boly ät a disk no compater can benefit, he says, because the chair counteracts physical and mental stess and rebe to hirosses concentration. He allos sens it as a contry place to fraid, wach TV, and, of course, medtale, in the not-so distant future, i will form ho perior base for vitual-neelity advertures. The chair will be on the emister share that proces will start at just under \$1000 for the setorederd morial

Once Park finished his design. NASA becan to look at the chair not only as a nifty spinoff of their research, but as a piece of comty hardware that could come full circle. Mounted on the astronauts' training platform, it could provide the ideal rectiner for smutations. Wearing goggles, the astronauts "will use virtual reality and feel like they're in microgravity in a miniature flight chamber," says Park That's a major mprovement, because "up until now, the only way to simulate that was to float in water tanks

MASA hopes to begin using the Flogston Chair in astronaut training in late summer 1984— Park is buye molfying it for them adding a spocial base so it can move actual R Bowen Lobe in, principal investigator for Advanced Training Exchanges at Johnson Space Certes, asys the Chair. This the pole-tilla to actual winds-flow that the source of the vital-reality experience, adding an amulast the behavior of the body in motion in space."

Park's space age designs have led him out of oil and into an entirely new career. Working with Oceaneering Space Systems, a NASA subcontractor, Park is also designing the space station reincerator and calley.

We just hope he still has time to meditate DO CONTINUUM

DEVELOPING A ROBUST TOURIST INDUSTRY IN HUNGARY: New World service in an Old World country. Plus, riding the lunar rails, and in space, no one can hear you sneeze

In many places in the world, the last thing tourist-besieged citizens want is more camera-toting. sensible-shoe-sporting foreigners in town. In the countries of the former Soviet Bloc, however, tourism is the golden calf, the industry that many see as their best chance for fiscal salvation. Consequently, these nascent nations have invested a large part of their hopes for the future-not to mention a hefty portion of their extremely scarce hard currencyon making themselves irresistibly altractive to travelers



Hungary is a case in point. Tamae Tegiseay, predicteriol the Hungaran Drumet Bord; and analized American who has returned home to help out, explains why his government is associated with the second secon

But developing a robust tourist industry is easier said than done. There is resentment in many quarters against extranationals jetting into town, brandishing wads of Doutsche marks or Japanese ven and buying up every worthwhile property in sight. Teglassy admits, "The nationalist parfies are screaming bloody murder that Hungary is being diven away to foreigners. But you can't have it both ways. There is no internal capital, so capital has to come from abroad or the country stagnates." Even when a suitable property is identhed by interested buyers, foreign or otherwise, there are further complications. Châteaus and manor houses that would be great all gussied up as spigné hotel retreats for the champagne-and-chandelier crowd are the subject of labyrinthine ownership disputes. Deposed counts are demanding the return of ancestral homes seized 40 years ago by the people's oovernment

But the thornest problems have more to do with atfluide than facilities. Prevously, most visitors to Hungary were from the Soviet Bioc or the Soviet Union "They dight have much morely to spend, and they weren't foo domanding." Tegliasey explains. "And since there was a huge shortage of hotei roorts, envore corring from the West had to settle for what they got. "Peter J. Letgeb, general manager of the Grand Hotel Convus Kimpranes, Budgedets Invests and nertest property, attributes the notaticusly inadequate service in Eastring and equate service in Eastple were frustrated, here was no way of advancement. There was no reward for pleasing the customer. You had the same job, the same pay, whether you served two customers or twenty, whether you wave counterus or not."

The Hotel Corvinus provides an object lesson in how a hotel should be designed and run, and it's determined to reeducate hose Hungarians who graduated from the Karl Marx schotol of ser-

vice. It is the first delixer burgarian hole constructed as a pint verture will a longing company. Uccated at one of the bow's man squares, its districtive post-post Salinist design trapis haid Delayeshi to come n The hole is not intended just to be a caseto for foreginen; "anyo Lettige "Weat owned in the square for the local community to gashin fails, food and beverage neoptic normally split 60 percent precidence, 40 excernal locals.

In given of the dut-event skew-moning functionnels utingtions in a tasket memory exception of the Marcak poing stars who make up for their galatis in English by think chem and cagarress to these. With our stark, we verified to dewiding committing next. In first to sait a stard which out do a a new committing interplay, says Langer, We were locating for service controls, says Langer, We were locating context, and the same start of the same start of the outside good locating, and highly noticed. We tran holding to mark a do complex management charts and know what the cleared are locating on "

There are at all obstacles, however, "Hungary needs a plotal bunst strateging that works," Leights says, "To encourage quality teurism, to attract people who will bung bring into a substrateging the strateging of the to consider that the strategy must be to attract more peote 0 Budgeest Whitter they strateging them here in the first place" half in the superclang them here in the first place" which is placed by Budgeest bungstrateging the the 1996 Wind's placed by Budgeest bungstrateging them here in the 1996 Wind's placed by Budgeest bungstrateging them here in the 1996

"Competition is good." Both Teglassy and Letgeb chant this fike a manina. In fact, the Hotel Corvinus may have done too good a job Letigeb says his competitors "are now trying to steal my personnel."—MELANE MENAGH



CONTINUUM



Fetal-nerve-tissue experiments currently underway with cats may eventually help repair spinal cord injuries in humana.

FELINE SPINE

More than 250,000 people currently line with spinal-cord injunes. Modern medicine has not yet found a way to reatore movement and feeling to their limbs, but experiments involving transplants of fetal nerve tissue could change that.

Paul J. Reier and Douglas K. Anderson, neuroscientists at the University of Florida Brain Institute, injected a kind of soup made of both solid and separated fetal through magnetic-resonance imaging (MRI) scans.

Two of the cats rejected the transplanted material, and three others showed no signs of recovery But eight of them regained virtually normal welking and stain-climbing ability, and two other cats showed measurable progress.

"The immune system is still the big hurdle," Beier says, "We're a long way from having a method that can be routinely applied in human medicine, but our

THE SURFACE AREA OF THE HUMAN LUNGS IS ABOUT EQUAL TO THAT OF A TENNIS COURT LAID END TO END, THE LUNGS' 300 BILLION CAPILLARES WOULD STRETCH FOR 1,400 MILES.

nerve cells and tissue taken from cats' brein stems and spinal cords into 15 other cats with humanilke spinalcord injuries. They grafted the material directly onto the nury sites, pinpointed findings indicate it may be possible."

Reier looks forward to the day when doctors can inject cloned cells to restore motor function, recent studies indicate that some

MICROBES IN SPACE

A cold or flu virus can spread like wildfire in the confines of an office building or a college dorm. How fast would such microbes spread in the even more cramped quarters of the space shuttle?

Researchers at NASA's Joinson Space Center and the University of Texas Medical School am to find out by studying the transmission of the bacterium Staphylococcus aureus from astronaut to estronaut Staph aureus is found in the nases of 20 to 40 percent of the population, where it usually does no harm Many strains of Staph aureus exist, each of which can be identified through DNA fingerorinting

The NASA researchers first frogerprinted the strains of Staph aureus in the noses of shuttle crew members before a launch. When the shuttle returned to Earth, the researchers checked the noses of the crew again to see if they'd swapped strains of bugs.

Although the study is not yet complete, it appears that microbes don't spread as quickly as the researchers had thought-or at least not as fast as studies. done in the days of Apolio and Skylab had indicated. according to Duane L Pierson, chief of microbiology at the Johnson Space Center "An Apollo capsule with three crew members was much smaller and more crowded than the shuttle. Pierson says And Skylab missions lasted much longer than the current shuttle

flights However, Pierson points out, during the upcoming longer-duration thatts of the shuttle and the space station, the chances of microbes traveling from astronaut to astronaut increase. "With all the things that increase the risk of infectious diseases in snace-a closed environment, crowded living conditions, limited capabilities for personal hygiene or for disinfecting things-we're trying to antigipate problems and plan for the future Pierson says - Devera Pine

embryonic nerve cells—Ideel for such purposes—may well remain in the central nervous systems of humans after they reach adulthood. The use of material taken from the injured patients themselves would neatly sidestep the rejection problem —George Nobbe

"America did not invent human rights. In a very real sense, it is the other way around. Human rights invented America." —...homy.Carter

Can a drug help binge eaters stay away from sweet foods?

FEED YOUR HEAD

Treatments for most people with eating disorders concentrate on psychological factors that might be causing the behavior. Research indicates that, indeed, binge eaters' problems might be at in their heads—but in a different way.

Binge eaters tend to consume large quantities of foods high in fat and sugar. Pecent research suggests that natural opioids—narcotics produced by the brainmediate the craving for these loads. However, the opioid mospitors in the brains of bingers are probably working overtime, resulting in an artificially high need for opicidis. This causes the bingers to eat foods laden with fait and sugar, which stimulate opioid production

Researchers have found that bingers have higher cpiod levels than do normal women, asys librivershy of Michigan nutribinist Adam Dievenowski in addition, some data indicate that a dirug calied natioxene, winch blocks the bran's cpiod receptors, can help binger newels locked at the effects of natioxer en bulmros-who tand to bunge and then purge---mot normal eletres

He and his colleacues. cave either naloxone or a placebo to 14 bingers and 12 normal eaters who rated their taste preferences for a variety of foods. In both groups, Drewnowski says, the participants ofven naloxone reported lower taste preferences for foods high in sugar and fat More important, "it also reduced the consumption of foods that were either sweet or high in fat or both in the binge eaters."

Unfortunately, naktorne won't provide an answor for binge estlers, Drownowski stys, because is effects don't list long enough. But now that the relationship between the brain and binge esting is better understood, he prodicts that "a chemical or pharmacuitical anticote for binge eating is on the horizon," - Paul McCarthy



Toss some sexweed on that first Three California inventors have found that dired kelp quickly quenches flames.

KELP, THE FIREFIGHTER'S FRIEND

Believe it or not, an industry centered around keip thrives off the coast of San Diego, Californis, where 2,000 tons of Isaly seaweed are harvested daily. From the keip comes a geletinous compound calified algin that helps keep ios cream smooth and beer foams

The algin-extraction process produces an unpleasant byproduct, a faby-smelling stury. Disposing of it presentiad a problem until three inventors from Damico, a stuck and heavy-eaupment rentil company in Chula Vista, Calforma, accidentally discovered that the stuff can enruft out frees and absorb and contain liquid fuel spread byten-tighting efforts.

Michael R. Bustamante, John J. Renaker, Jr. and Donald A Megley had actually begun testing the slurry as a potential soundproofing and ol-absorbent material; they also wanted to use the teelo as an alterne-

AMERICANS USE 69 MILLION TONS OF PAPER AND CARDBOARD EACH YEAR

tive fuel. During one fuel test, they got a bigger blaze than expected—much bigger Someone tossed some dried kelp on the flames, which douzed them in seconds.

"The product-safety tests showed the substance was 10 percent water, 45 percent kelp, and 45 percent peritte, a filtering agent," Bustamartia sava.

Taking advantage of its seendptlous discovery, Demoo now makes firesuppressant bricks, fiskes, and powder. The company moes the kelp sludge with water, smooths it out in a two-inch layer to dry in the sum, mulches it more something recentling faith the sum packages. It in for something recent bright the value – George Nobbe The briefs are used to build fire walls – George Nobbe



CONTINUUM



In patients with heart disease, simply recalling anger produces a physical reaction similar to a heart strack.

TELLTALE HEART

We've all seen movies in which a character becomes emaged, lurne beet red, and keels over from a massive heart attack. While Hollywood overampiles the situation, according to Stanford psychiatrist C. Barr Taylor, new research indcates that anger could probably bring on a heart attack in a main with severe heart disease

Taylor and his coworkers exposed one group of heart-disease sufferers and another group of healthy controls to various forms of stress-riding a bioyote, giving a short speech, doing manual anthmetic, and recalling an incident that produced anger. Surphilingly, in the heart clissese patients—but not the control—the recalled anger oaused the greetist reduction in the emount of blood lowing from the left verminel of the heart to the sorts and out to the body in a more exaggerated form, this phenomenon could lead to a hear tatack

Anger may cause the blood vessels that lead to the heart to constrict or spasm, making less blood available to the heart. Taylor speculates. Simply remembering an anger-related event brought about a mild form of this reaction, but actually expenseding anger could potentially have more severe consequences! Subjects asked to compare recalling anger to experiencing anger deemed the real thing to be twice as stressful.

Still, Taylor doesn't want to scare men unnecessarily. Only those with sovero heart disease have anything to

BREASTS, BOTTLES, AND BABIES' BRAINS

Wheth's better for baby, the breast or the bottle? The clebade has reused on fair at least half a century, New researcher's in Statismel have come down squarely, on the cide of the breast Mather's mile, say the screeties, contains a substance vital to the development of a baby's brain.

James Farquiharson and his colleagues at the Royal Hospital for Sick Children in Glasgow examined brain tissue from 22 babies who had died during the first year of ille. The babies who had been breast fed, the worry about, he cautions, and even then their risk factor depends on "how open and how diseased the blood vessels are."

-Paul McCarthy

"The more things change, the more they remain insene." — Johnny Carson

researchers discovered, enowed significantly higher levels of docosahexaeneic acid (DHA), a poyumisturalel fatty acid known to be an important nutrient for the dwarkphing corrobral cortex.

There's no doubt." Farquinarson says, "that DHA in appropriate concentrations should be doing into formula mik" for mothers who choose not to broast field. Some non-U.S. manufacturers, he notes, add small amounts of DHA to formulas intended for premature babies. But, he save. "ès far as i lonow. there are no American companies currently inciding DHA to their formulas." -Bill Lawren





CONTINUUM

GETTING GRAVITY

Years of study on board manned spacecraft have prown that weightlessness causes the progressive loss of bone mineral and decreases cardiovascular conditioning, resulting in a rapid heartbeat and low blood pressure when astronauts return to Earth. On extended visits to the moon and Mars-with gravity of 17 percent and 38 parcent of Earth's, respectively-space travalers may well run into the same problems. Lex Schulthois, assistant professor at the Johns Honkins. hospital, succests that a remedy to the problem might be "virtual gravity"-a railroad that will create Earth-level gravity on the moon or another planet.

In Schulthes's plan, a laboratory, office, of living quarters loaded onto a train of sorts would move along a steeply banked track. The centripstal acceleraion resulting from the benking of the track would augment the planet's gravity, the level of which could be adjusted by varying the angle of the bark, the radius of the bark, the tracks are the track, and the train's speed. The colonists could live full-time in the moving facility or simply make periodic visits.

"Banking a track is not new technology," Schultheis explains. "It's simpler than, for example, developing a new drug that may exhibit side effects ten years down the road."

He's now studying how much gravity is needed to maintain healthy bores and cardiovascular circulation. His studies also cover how acceleration and rotation affect balance and vision. —Patrica Barnes Svaney DURING A FREAK STORM IN SOUTHERN ENGLAND IN 1987, 15 MILION TREES WERE BLOWN DOWN.

MAKING BAGS OUT OF GARBAGE

A biologradable plastic film derived from cheese whoy and waste potatoes could have a big future in compost bege and as a substitute for packaging material now coalid with polyethylene or inydrophobic wax. The new firm breaks down into lactic acid, a natural chemical found in both milk and the human body

The process, developed

at the Argonne National Laboratory, uses enzymes to convert the whey and notatoes into glucose syrup, which then ferments with bacteria to form a lactic-acid broth according to Argonne polymer chemist Painck Bonsignore, After electrodialysis separates the pure acid from the broth, the acid is heated to release water molecules, leaving molecules of polylactic acid that can be formed into time and coatings

"There are still a few gray areas micking problems with a high enough puth of the lactic acid." Bonsigners says. EcoChem, a joint vontare between Du Pont and Cen Agra, and Cargil intend to begin producing the film this year for sale to manufacturers —George Nobbe

A monoral on the moon may keep astronauts healthy

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Reaping the whirlwind



ot quite half a contury ago, had you asked meteorologists hether in the 1990s a powerful hurricane could chop the communities of south Florida into matchwood, they very likely would have chuckled at your lack of vision. Everyone knew that well before the year 2000 there would be an operational technology for weakening severe storms before they made their destructive landfalls. A squadron of aircraft dedicated to hurricane suppression would stand by through each summer season. When a major storm veered toward shore, the squadron would launch an attack, seeding the central rainbands until the destabilized hurricane's winds faltered. At the turn of our century, coastal homes might still be losing shingles, but hurricanes would no

ARTICLE BY CARL POSEY



longer kick their way through our towns and cities like booted giants

Of course, the visionanes of the 1950s and 1960s were dead wrong. When hurricane Andrew ripped through south Dade County in August 1992, shredding the area's light-frame structures with its powerful winds, it arrived untouched by human hands. Badar had swept the storm during its advance, satellites had montored it, computers had simulated the various paths it might follow on its landward run, and aircraft had probed the storm again and again But the operational technolgov that everyone knew would be in place by now was nowhere to be seen

Not that the notion of blunting hurricanes had been tested and found wanting, however. After a flurry of support, weather modification was simoly written out of the federal agenda in the Carter and early Reagan years. Vaporous diplomets, dissent among sciontists, and the elusiveness. of statistically viable proofsstatisticians and their appethe for significant samples, af-35 OMN

ter all are the undertakers of daring science-combined to suffocate the clas before it could be tested in the field. Even nature played a hand Contrary as always, she cut off the supply of seeciable humicanes and simnly outwaited the truncated attention span of policy makars. Today, observes one long-time researcher, you don't even hear humcane. modification mentioned: nobody wants to think about it.

For most of human history, the idea of somehow taming the viglent creatures of the atmosphere has been treated only as fantasy, as magic A sorcerer like Shakespaare's Prospero might have "call d forth the mutinous winds and 'twixt the green sea and the azur'd yault set roaring war." but everyone understood that such stuff was Faustian nonsense. No one knew this better than manners. They'd gone through hurricanes. lost ships and shipmates to the big storms, and experianced the metaphorically beautiful caim of the central eve, where there might be white water aplenty but the



air was cairn enough for seabirds to gather and for battered ships to rest before being overtaken by the cvclone's trailing edge There was also comething intensely personal about being thumped at sea by an Atlantic jurricane or wastern Pacific typhoon. The great storms were redolent with a kind of mystery-when people in the hurricane trade talk about Donna or Camille, they seem to be talking about more than just another natural phanomenon.

Radar, invented during World War II, robbed the storms of some of their imponderable qualities. On early radar screens, the storms appeared as white Borschachlike brutes of cloud ringing an empty center, thair 200-mile diameters com-

Andrew ripped through Paradise Point (left) and Fort Lauderdale (center), generating the equivalent energy of a ten-megaton bomb--not for a second. but constantly, for days, Seen from space, Gladys wallops the Caribbean (below).



pressed neatly into a sixnch pathode-ray display Probing the storms with aucraft also drained away some of the mystique, despite the almost legendary roughness of the ride. These deadly spirals, it turned out, were rather easily area.

Looking at their meteorology, you could tell at once that they were really just oversized heat engines. Warm, moist air near the ocean surface was being drawn into a soural around a center of very low atmospheric pressure, then spun into a cylindrical wall of violent convective, vertical clouds around an eye. Adding the energy of its load of freezing water to the storm's, the air was rammed up this chimney to exhaust some ten miles above the sea in a vast shield of frozen cirrus clouds. But in that powerful, rather simple, process. there seemed to be something frail and unstable. Like the engines of Indy racers. humcanes seemed always poised on the rim of mechanical failure. Perhaps, a few mateorologists dared think,

that fraility was a handle shaped to the human hand—a way for us to tinker with the enormous energies of the humcane

Robert Simpson, a rangy physicist from Corous Christi, Texas, was one of the first to see the cossibilities. Working as a tropical meteorologist and hurricane forecaster in New Orleans and the Carlobean, he'd followed the progress of early cloud-seeding experiments in New England, where dropping silver jorkide into strafiform clouds filled with supercooled water-water chilled below freezing but still in liquid formhad permitted General Electric researchers to carve a big "GE" in a winter cloud deck. Supercooled water waited only for a microscopic crystalline parti-turned to ice. Silver iodide provided the publet. "It was heraided all over the world as the birth of a new age of weather modification." Simpson recalls today

The people in power also began to

think about humcanes. During the 1950s, the tropical Atlantic sent one maor storm after another bitwheeling toward the United States. In just two vears, six severe hurricanes-Carol, Edna, and Hazel in 1954, and Connie, Diane, and Ione in 1955-caused what would today be some \$10 billion in damage and took some 400 lives from Georgia to New Encland, its attention grabbed the government ordered the Weather Bureau to do something. and Simpson was given the task of creating the National Humcane Research Project, which began working from its Palm Beach, Florida, base in 1956. "I built in some experimental specing "be says-"not to modify the storms, but just to see what would happen "

At first, very little happened. The arborne burner designed to produce a plume of silver-ixidide-enriched smoke was hard to light in the hurricane. "We had several abortive missions in 1957," Simpson says "It was all sub rosa. In 1958, we got the instrument to light and seeded Daisy on two days " A small. strong storm. Daisy showed no detectable effects in fact, the researchers would have been able to see only the most obvious changes. Badars of the day could discern the soural of rainbands and define the evel but nothing on the aircraft permitted realtime readmas of the winds or the proportions of water and ice in the clouds. Simpson and his colleagues were, in a sense, the alchemists of meteorology, following instinct and intuition more than the welldefined track of a mature acience.

In 1959, Simpson returned to the University of Chicago to finish his Ph D, which had been interrupted by the war, and there he experienced the oppharig that shaped all subsequent attempts to modify humcanes. "My friend and desentation adviser was Horbert Reh/," his says now. "On his own, Richi came

DOING SOMETHING

Whenever a hurricane like Andrew savages an American community, ideas pour in for hitting back at the devastating storms. Some

offer recipies for homemach bonits or, most offen, ask why hurricanes can't be hancked like a contain maternal alien and muked liem othist. Offen ers worlder why the supplet accuscies of smart weapons in Desert Storm can't be applied to knocking out hurricanes. Radioactivity askip the violent energies of these great storms make anything humans can hand out thriai in the actome

Hurricane Andrew, for example, generated the equivalent inergy of a ten-megaton bomb continuitys during its parasign—notif or a split second, as in a bomb explosion, but all the time, for days. According to one and, as the abomb explosion, but all the time, for days. According to one energy represents a large fraction of global energy consumption. Would such a powerhouse oven fiel a nuko? Phobbly not.

More tempting suggestions involve tinkoming with the heat-engine side of the hurricane, either by chilling its warm core—some propose bombing the eye with liquid-nitrogen bombs, sthers with liquid-nitrogen bombs, sthers with liquid-nitrogen bombs, sthThe services of the warm occasi from which humans disa their of cattering Laying down a sheet of cattor back or important the reduction take or important the reduction most services and the mechanism by which the down suck heat from the sea-to wasken the winds if o cattors, such schemes also poste problems of cleaning up A camendocularishich film in topic rease conditions might not be easy to get red of new factors to be easy to get red of new factors and to be easy to get red of new factors and the search of the start of the search of the search of the search of the rease conditions might not be easy to get red of new factors and the search of the sea

Alternative proposals look all ways to bring the colder waters at depth up to the surface, again in an effort to make the hurricane chill out. This kind of attempt would seen the coen shead of the ackancing storm with such devices as wind-raiven underwater confectewas and bubble generators that would force cold water to well upward.

These ideas have morit but still underestimate the size of the storms A major humcane might be ten miles high with a core some 50 miles across, wound with rambands going, out more than 100 miles. To make a difference, dropping coolants in from the top would require thousands draent ankers. Changing water femperatures ahead of the storm would histwise require millorts of expendeble devices: deploying them would be a daunting task, to say the least, and very expensive.

Thus far, there is still no human technology known that can counterpunch with humicanes-the volume and enercres of the storing are just too much for us. As scientist Hugh Willoughby puts it, "At the energies of interstellar flight, direct intervention becomes possible " But he also sees a ray of sunshine-a literal one. Eventually, he believes, humankind will have to go to space for its energy, perhaps us ing vast mirrors to collect solar enerov and beam it, in the form of micro wave radio waves to the surface. Such mirrors, he muses, might be used to shoot a blast of solar radiation into the heart of a hurricane as it forms, defusing it at birthdown to Norfolk and asked the Navy to fly him through Donna," a 1960 hurricane. "So they took a let and flew him back and forth over the top of Donna. se che annynachert Floreria. He traix protures-pictures of what the radar saw Donna was a very steady storm. It had this chimney in the right front quadrant. Riehl said the offluent from this chimney created the entire cirrus shield over the storm. He came back all excited We got together I said. 'Did you get any icing?' He said that every time they went through the front quadrant, the plane got ice all over it " No one cried gureka, but a hypothesis was born

Simpose had been looking for some trugger, some titled, with which to take advantage of which the take advantage of which the take storms in therent instability. The prosfield of upper cooled water differed one. Water gives off enormous quantities of stored, or later, heat when it changes phase from tiguid to ice. If by seeding you could ooks it is supprocioal water to fraker, you'd release the purchare. perhaps arough to make a difference. "I developed the importance in the you" release more that," Simplo explains, "and change the unifice pressure gradent that controlled the flow of wardrelease that controlled the flow of wardso steep, surface wards would not coll quies outpity around the conter of low ensore, the sound the conter of low wards outward, referring a greater reading from the cated here, like a wintte hum reaming works would dipo.

Back in Paim Beach, Simpon soon tend his typothesis in the field. On September 16, 1981, a maked squardin of Navy and Washer Eluseus aircraft converged on humreane. Estimer and diopede eight shere-icidio cansters into clouds around the eye- the amultidioped the shere-icidio cansters into clouds around the eye- the amultishere, match that been short the eye wall. Estime, which had been short the eye wall wall weaknows agnificantly. The next day, the planes thest again, but this me the cansters imised the eye wall and no changes were observed. No chger perhaps, but on the whole, an encouraging start. In fact, Esther's behavior was encouraging enough for humrosen modification to move 'hito the light in 1962, the U.S. Navy and Deparimetric of Commerce established Projed Stormfury-band Strongson's idea Nardvect into the Stormfury Hopothesis

By now, however, cloud seeding had acquired some scientific trappings-it was more than just the introduction of a seeding agent like silver iocide. A techmoue called "dynamic seeding" had emerged, in which seeders sought to alter the very structure and wind flow in cumulus clouds. By causing supercooled water to freeze and release latent heat into the cloud, they could force the cumuli to grow, drawing increased quantities of surface air in at the cloud bases and exhaling greater quantities of frozen effluent at high altitudes. Simpson and his wfe Joanne, an experimental meteorologist, incorporated dynamic seeding into Stormfury Seeding, they postulated, would

OUT OF AFRICA

Some hurricane seasons are more equal than others. A map of the tracks of severe Atlantic hurricanes—those with winds greater than

110 miles per locar-from the end of Weidr Wait (Houngh 1969, the year that gave Sternfury Dabbie to seed, is a langle of destructive stands. From 1970 through much of the 1980, storm earlier weight have observed Nexe methorshow was observed Nexe methorshow the destruction of the endly mattered accord barg that the endly mattered or half a century app are now dense by papelated county Dable County. The potentiate of weight Dable County. The peterted damage in resolutionshows the damage and the endly mattered and an endly and the second and the damage in resolutionshow the second barget bart and analysis.

No one can say for sure that humcanes are actually on the norease. To some scientiss, the researd fail in the incidence of destructive storms is merely a random learng of the conditions over the tropical Attentic that spawn humicanes. Other observers, however, see an omnously predictable cycle of activity linked to forces somawhere else.

To many meteorologists, 'somewhere else" is western Africa. Decades of watching the seeds of humcanes flow westward from that continent and blossom into humcanes over the warm ocean have led experts to look for connections between Africa and the frequency of hurricanes, but the actual mechanism has proved elusive. Some have postulated that African dust in the trade winds suppresses the formation of hurricanes by blocking solar radiation, others succest that the grains seed the moist tropical atmosphere, abotting the growth of young storms.

According to William Gray, a metaorology professor al Colorado State University, the key factor appears to be the amount of ramfall in west Anca. The years of frequent service Atlantic hurricanes coincided with years of abundant ramfall over west Africa. The continential storms that produced the heavy tarins, in Gray's view, may have set up conditions in the easterly trade winds that fostered the formation of humcares. Conversely, the humcane famme that lasted with a reventess drought in western Arisa—a storught with that sont no humcane-spawning pulses out over the Atlantic

Now, Gray reports, the African drought shows signs of ending. If it is, and if Gray's correlation is true, the American side of the Atlantic is in for rt. There are already omnous signs of an increase. Gray notes that there have been ten severe hurricanes. since 1987 Gilbert, Helene and Joan in 1988. Gabrielle and Huco in 1989; Gustav in 1990; Bob and Claudette in 1991, Andrew in 1992, and Emly in 1993. While Gray acknowledges that the signal remains far from clear, that violent cohort of storms may be the harbinger of humcane seesons to come.

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cause the inner rainband clouds to grow at the expense of clouds forming the eye wall, creating a new eye wall with a larger diameter and a concomtant reduction in maximum winds.

Eike all experiments conducted in a natural laboratory, nothing about Stormtury was easy. The storms had to be with in range of the research planes but predicted not to touch any populated island or coast for at least 24 hours after seeding. The 1962 sesson brought no candidates. The next summer, after obtaining strongly positive results in cumulus seeding runs, Stormfury turned to hurricane Beulah, which had steamed into range. On August 23, the II-formed storm was still a marcinal candidate for modification, and the seeding material feil short of the eye wall's cloud turrets. Nothing happened.

The next day, however, the storm had intersplict and farmed a well-developed eye. This time, the seeding canisters were on the mixth. The original eye wall distributed in an extension eye wall replaced it. And, as prediced, the maximum winds decreased by about 14 percent and moved farther from the center of the storm.

Nature not only abhors a vacuum, but he is more time a tille lessy about success in tyring to tame the In 1964, down because their instrumentation wear? needy. The nod year, the planes there in burnic Bebry, which was too close to land to seed. Elems, a second to the other betty, which was too close to land to seed. Elems, a second close to land to seed. Elems, a second range. In 1968, Table side to the ward the north-east, abnot of the seeding area. No hanchow to the solves during the inter tables too the solves during the inter tables too they hed these for one soom.

And then along came Debbie

On August 18, 1969, thirteen Stormfury aircraft staging out of Puerto Rico seeded the humcans, using Navy A-6 Intruders to drop hundreds of silverlocitide-producing pyrotechnics along a line through the eve wall. Debbie's winds dropped 31 percent after seeding. A couple of days later, with the starm once more spooled up to its original strength, a second seeding run was followed by a 15-percent reduction in maximum winds. Curiously, while massive resources worked the oppoprative Debbie humcane Camile-one of the most intense storms ever to strike the United States-was taking aim at the Mississioni Gulf coast.

Anxious to replicate their success with Debbie, the Stormfury team waited for a second opportunity, But, again, nature intervened, No candidate appeared in 1970. The only eligible storm in 1971 was Ginger, a poor thing, of a lata-season hurricane, iiil formed and diffuse; predictably, the ensuing desplorate seeding of Ginger did nothing to the storm but cast a pall on the experiment During the 1972 season, hurneanes stayed out of reach of the arplanes. Although no one knew it, Stormfury was over.

"We entered a period when the hurricane tracks we needed just didn't materialize," recalls Peter Black, a humcane researcher with the National Oceanic and Atmospheric Administration in Miami. He'd been present more or less at the creation and had shared the high good feelings after Debble. But those feelings soon began to fray. "Each year, permissions from Caribbean countries became more difficult to obtain-Cuba, Maxico. The State Department made our quidelines fighter. Finally, we had only a narrow zone north of Puerto Rico and twenty-four hours to landfall then thirty-six hours." The rules of the Stormfury game changed yearly, each chappe placing storms a little bit farther out of reach. "When I was first there." Black says, "there was always this idealistic attitude. We were going to do something significant-a mission to help the quality of life That's seen as a fantasy now

Project Stormfury Iwed on for another decade, however, fueled by the Debbe results-and tainted by the impotent try with Ginger in the early 1970s, the Navy pulled out of its Stormfury partnershin, and the Weather Bureau-now NOAA-arcraft began to wheeze. Until then. Stormfury had flown in DC-6s. topped by a high-flying B-57 jet bomber, the New had contributed its WC-121 Super Constellation hurricane huntors and the A.6 seeders. Without the flotilla of Navy planes, researchers had either to abandon Stormfury-and the promising start with Debbye-or give if a new shape that matched reality. The government chose to go with the experiment. Two specially built WP-3D Orion aircraft were nurchased for about \$10 million each, and the tempo began to build in NOAA's humcane research, Planners began looking for the natural laboratories offered by other oceans-the frequent hurricanes that spin up the coast west of Mexico, away from people; the huge, intense typhoons of the western Pacific that occur, from an expermental standpoint, at least, with

"They couldn't find an ocean that would have them," says Stanky Rosenthal, recently refired former director of NOAA's hurricane research lab in Mami. The problem of labitly witched off interest among politicians in Australia. and at home as well: Towns might sue you for seeding-or for not seeding, if you knew it would help-a storm on its way to trash them "The Japanese killed any hope of taking the experiment to the Pacific. They had political reasons. No country wanted to be hit by storms that were made in the USA. The eastern Pacific was scotched by the Mexicans. We tried to see what we could do in the Atlantic." Rosenthal had nherted Stormfury and dutifully pursued it. "I was not an enthusiastic supnorter, not a true baliever in weather modification, and never became one," he says now

Constrained to a small trapezoid of open ocean orth of Puerto Rico, the Stormtury squadron – now two NOAA MP-305, a NOAA C-130, a borrowed Ar Force C-130, and NASA's Carwair 900, Galilloo III-watted for an alort act, year through the last hall of the 1970s. It never came. "My thoughts ware to go all out, make every effort to seed a (sw stroms," save Stoenthul, S

"show that there wasn't a great deal in the idea. It new en occurred to me that politicares could get ahead of me." But they did. "Politics took over, The cuts were in the Carter budget." Including the aircraft, Stormfury had cost about \$30 million in all—roughly the price of two space toffet profetypes.

In 1981, hurricane Floyd and hurricane Harvey pranced through the Stormfury area, as did another Deb-

bie, a marginal target, in 1982, In 1989, Gabrielle and perhaps Dean were elgible, as was Gustaf in 1990. But, from 1990 orward, there were no Stormfury planes waiting to seed them.

Although the new aircraft were not seeding, these remarkable flying laboratories still probed each season's storms, taking into the swirling may of the hurricane all the tools that Bob Simpson never had. Knollenberg imaging probes permitted scientists to tell liguid water from ice. New cloud-physics the distribution of nuclei. Digital-and, later. Doppler-radars could monitor three-dimensional wind fields inside the storms, giving researchers their first detailed look at the hurricane's interior structure. On-board computer workstations. allowed realize analysis of what the sensors picked up from the roaring gales outside. And the WP-3Ds, these starships of atmospheric research, possessed bone-ratting endurance. They could spend ten hours or more buzzing around inside a hurricane.

For the first time, measurements takon in hurricanse were not point's of data along a hurried line through the starm, they were consolutive data taksolution of the start of the start of the Shaha davays in the hurrcane. Gradually, the simple strute envisioned in the 100% became an almospheric créature of sturming correlexity and mote, the accredit staved that hurricanes, like wergything eldes in the attropping decreder the start dartopping.

"About 1977," Black recals, "we begraphting a few measurements," The weakening process Stammurg weakelow induces, the solicitatis began to realize, hoppened quile naturally "in the 1980s, we though the an aroan on, up, and out. We didn't appreciate the impact of anurgent the solicitation of sol

AFTER A FLURRY OF SUPPORT, WEATHER MODIFICATION WAS SWELY WRITTEN OUT OF THE FEDERAL AGENDA. DISSENT AMONG SCIENTISTS HELPED SUFFOCATE THE IDEA BEFORE IT COULD BE TESTED IN THE FIELD.

was what it had once seemed

Nothing was less so, however, than the ope wall—how control cyfinder of lowering clouds and maximum winder, which is really white a huncane is all about it once seendo to be a straghtoing head from openies at a set nees, spewing it out at high althudes in fact, the year of the like the revolving breech of a colosally complicated site activity in a poper tut set. In a poper contain a poper tut set. In a container spending, maximum and of the spending, maximum and of the spending, maximum and of the

"The center of enculation is offset." coplanis Black—"ssymmetry. hurricane researchers now belives, emportant to the way the stoms move and intensity. These titled consolution that the moving breach—see abordrates in the moving breach—see aborlived, lasting only 10 to 20 minutes. They are matched by regoons of what Each cass forced secent caused by factors outside the stom. In Andrew he says, the updrate turnets and sees of forced descent slowly rotated around the center of low pressure at about 50 miles an hour, embedded in the eye wall clouds

Critics of the Sternfury hypothesis, like hurricance researcher Hugh Willoogtby, believe there series the hugh stichembers to make much difference. "I hurden is freazong anyway, what hare you changing?" he asks. If we were allinoving, partages we could say yes, the is being caused by iseeding. I couwere hypothesis we could say yes, the is being caused by iseeding. I couwerlieve you's done that ' you might be able to intervene and provide some hing. Dut you'd news' know'

Not surprisingly, Bob Simpson diffors. "The bone of contention is not whather there is a way to modify humcanes if you have supercoded water in them. The question is, do you have enough supercooled water to make a difference?" Just back from a 1996 experiment in the Corol Sea, where he had a chance to look for supercooled

water in a Pacific storm called Oiver, Simpson says, "With more sensitive instruments, we found much liquid water at bolow -40 degrees. You can't take bits and pieces and pui them together and draw conclusions." How drath to be the sensitive them to be the sensitive the sensitive the sensitive the sensitive them to be the sensitive the sensitive the term of the sensitive the sense the sensitive the sensitive the sensitive the sensitive the s

Only where you had the convective maximum did water have trouble freezing. Now it's debatable whether seeding in the eye wall is a viable hypothesis; that's still subject to argument."

But the presence or absence of supercooled water at seeding altitudes-from about 20,000 to about 30,000 feet-is not easy to verify The heavily loaded P-3s must labor mobility to get up above the freezing level in hurricanes-something over 20,000 feetuntil late in their mission, when they've burned off much of their fuel. It's a bad level for thing. "There's a lot of lightning," Willouchby says. "You get hit a lot. You become a flying hailstone." And de-icers, he adds, take a lot of energy from the engines. Because icing makes this stratum dangerous flying, nothing like a systematic inventory of supercooled water there has been made

As Stormfury foundered at the end of the 1970s, starved of storms and perhaps of supercooled water, nature played another prank. Flights into 1980's hurncane Allen while it spun across the Guilt of Mexico revealed procisely the kind of wind variations that Boomfury accentistic had measured in Boomfury accentistic had measured in the of a section, which we accent on the papened all the time, naturally in a kind of reagnition, the over expands outwird and maximum which diminish Mereover, humtenase evidently serout concentre, eye walls all the time-1089's Camille tad box, for example. Again, the cleaned affect of seeding acceled atoms.

Such news meant different trings to different scenits, depending on whether they were. Scentrility between a inserved that the changes seen in a sected Debbie—and in the earlies toms as well—were merely at illusion of furnant intervention, a nitural contentions are well—were merely at illusion of human intervention, a nitural contentions are not well as a section of the section seen in Alten show that the structural humans. Stormbury hoped to achieve meany, as Simpson possibilist, to be this gread by score human agent.

Robert Sheets, director of the National Humcane Center in Coral Gables, Horids, directed Stormfury during the

1970s and until its demise early in the 1980s. A scientist who has spent a long research career flying around inside hurricanes. Sheets remains a true believer. "I was converted by the Debble results." he says. He himself analyzed the data, and it convinced him that the hypothesis is correct. "What we can't verify is that we caused the change," he says. "The magnitude of the system sort of overwhelms what can and cannot be done " Sheets has worked with hurricanes since 1965. when he joined the hurricane lab "There's no question that there's supercooled water." he says "Airplanes get covered with ice, but it seems to occur in fimited areas. Tremendous updrafts In nature are also seeding the storm perhaps." He adds. "There's still the question of whether there is enough supercooled water that can be utilized to modify the storm. Some say eye wall fluctuations show seeding does no good. To me, that says the hypothesis is correct."

To believers, those pulsations, the alternate filling and deepening, dwinding and rewing up, of the eye wall are a modern corollary to the fraity inferred by Robert Simpson nearly half a century ago. Those natural oscillations of the siye wall may be the wished-for handie shaped for the human hand—"If one could inhibit that cycle when it reformed an eye at its larger size," speculates Peter Black. He grins: "But this isn't even hypothesized—no halway conversation or even bad jokes."

In normal times, there the matter would rest. But while such storms as the tropical sea, causing the hardships of a war along American coasts, some scientists have begun to see a cyclic increase in the incidence of severe hurricanes. The dearth of storms that beloed throttle Project Stormfury may soon be replaced by a flurry of them (see "Out of Africa," page 42). But the search for a technology that might have mitigated their terrible winds was abandoned more than a decade ano. "An unfinished symphony in a sense. reflects Stan Bosenthal, "Stormbury was premature. A lot of the things that were being done in weather modification were being done without proper tools We go into the next century with Doppler radiars, atmospheric profilers. We're just now getting the tools in hand "

Yet no one today believes those modem tools will be used to blurt the tury of the hurricane. As things stand now, what nature sends spinning from the warm sea, we must meekly accept as always DO

NICKS.

NICKS. NICKS.

NIX.

UTIMATE CLOSENES

NOW EDGE GEL EXTRA PROTECTION FORMULA has more friction-reducing lubricants than ever to protect you from nicks and cuts better than foams. For a closer, smoother shave, its just in the nick of time.

ULTIMATE CLOSENESS. ULTIMATE COMFORT. THAT'S THE EDGE.



TODAY'S HIGH-TECH SOCIETY-EVER MORE DEPENDENT ON ELECTRONIC DEVICES AND CHIP-DRIVEN GADGETS-IS INCREASINGLY VULNERABLE TO LIGHTNING HITS

eardrums damaged." save Uman, a genial electrical engineer. Uman's intonations sound like Jimmy Stewart's. but his subject is pure Vincent Price. He holds up a twisted radio antenna. "A lifeguard was killed under this little guy." he says. He points to a blue research rocket that was used at Kennedy Space Center to trigger lightning. Its fuselage is melted and bubbled. He picks up what seems to be a fosalized condom. It's a fulgurite. created when lightning melts a tunnel in sand, which hardens again into a permanent artifact of the strike.

This minimuseum sends a message: Courds bits. To prove it, Uman hidds up a steel plate through which lighting burned a helf-adler-sized hole. But collecting such cuross is just for kicks. The Lightning Lab'r eral business is studying the physics of thunderbits. It isn't Nory-tower work, today's high-tech society ever more dependent on electronic gear—ts increasingly vulnarable to lighthing hits.

And there are a lot of hits. At any moment, planetwide, about 2,000 thunderstoms are in progress. Each storm generates a flesh every 20 seconds. In the time it takes to read this sensed, lighting has fisshed more than 500 times.

Most of the lighting flashes we see are cloud-to-ground stokes, but they comprise any about 20 percent of lighting Much more frequent are flashes within locked. Lightning also flashes between douds, or a boil may short by from a cloud into the ether and to can standstorms and muclear blasts. Even anowstorms can generate lighting and bundor:

Researchers know that most cloud-to-ground lightning is 52 OMN





Strike Force: (lop): storms erupt digitally enhanced regularly during image of a summer Arizona summers (above left) lightning storm over Tucson, Arizona due to moist air that (opening spread): flows in from the Gulf of California. hackvard demonstration of a Tesla collides with the nearby mountains, coil by Bill Wyseck and is forced (pravious page inset): lightning flash upward, where it condanses into illuminates a water spout over Lake thunderclouds: Okeachobee, Florida





negatively charged, but a small percentage of strokes are positive. And, rather than starting in a cloud, some strokes run in reverse, starting from a skyscraper or tower and shooting up to a thundercloud.

Lightning takes other forms, too, like seemingly thunderless "heat" lightning. Actually, the lightning is so far away (more than 25 kilometers) that the sound wayes dissipate before reaching your ears. Thunder may be the one aspect of lightning's physics that scientists believe they have definitely pinned down-but it's been a long haul. Rome's Lucretius said thunder was the sound of clouds banging together. Early-twentiethcentury scientists also got it wrong; they theorized that lightning created a vacuum along its path and that air nushed in with a thunderous rumble. But scientists now know that a lightning stroke instantly beats the air around it to searing temperatures. The superheated air expands explosively. In the process, it generates the sound waves we beer as Euroder

Scientists also have figured out such freaky phenomena as ribbon lightning, which looks like a broad stream of fire. It's actually a succession of strokes, each blown a bit to the side of the previous stroke by wind but strilong so fast that we see all the strokes at once as a ribbonlike fiash. Liphtning comes in other variations, too. Sheet lightning, for instance, sets a cloud glowing like a fluorescent tube. Bead lightning breaks up before your eves into a beadlike chain across the sky. And lightning can be triggered artificiallymost bolts that hit airplanes are now known to be induced by the aircraft itself. Much about lightning, how

Much about lightning, however, remains elusive. For instance, initiacical flashes—the most frequent—are short to see and study that their dynamics are still largely unterported to the standard state of the standard of even some basic clous-the-ground mechanisms, such as oxacity how giften Robably his biggisst mystery is ball giften Robably his biggisst mystery is ball giften and a giften in our state of the Robably his biggisst mystery is ball giften and a giften in our state of the state state of the state of the state of the everything from atipitals classifies to pertain a gifting. Which plagues is with everything from atipitals classifies to pertain a gifting.

Sencus lighting studies began with Anstotic, who got off on the wrang, foot, he said lighting was burning wind. Even this was a step up from the standard fourth-centurysic notion of a backetmored doity hung obtabil javemer. As loss as the 1700s, people thed backetmored have an another light an frança, meaning, "I break the lightra frança, meaning," break the light-

ringers were electricuted in the process. Not until 1752 did Ben Franklin try a kite in a storm, nearly barbecuing a Founding Father. He verified that lightning is electrical, the big brother of the sparks we generate when we shuffle across a rug and reach for a dowlooth.

Martin Uman says modern lightning research began in the early 1900s, when British Nobeltst C, T, R. Wilson measured the electrical charce in

lightning storms. Wilson theorized that lightning is triggered when clouds become electrically charged, positive on top, negative on bottom, ever since, scientists and meteorologists have been testing Wilson's theory. They use cameras to snap a lightning flash's multiple. strokes. They point antennas at thunderstorms to sample electric fields and radio waves. They send unmanned rockets and instrument-packed research planes into lightning storms, hoping to get hit. They even monitor the acoustics of thunder to eke out data on the lightning that produced it. One result is that Wilson's theory has been vertied: The typical lightning-producing cloud is indeed positively charged on too, negatively charged inwer down

But scientists are still arguing over just how clouds become electroally charged, and the overall lighting ignorance gap is increasingly urgent. For one thing, lighting is far more frequent than most of us realize. Lighting flashes even more frequently inside clouds, and our society—increasingly electronand our society—increasingly electronio-is over more vulnerable to these atmospheric outpursts.

Lightning can sizzle electric lines, and today's proliferating chip-driven devices are particularly sensitive to lightning. In airliners, for instance, hydraulic controls are giving way to the electranic cockpit. Even finy currents from a lightning hit could set computerized instrument pagels buzzing-a spooky thought when you consider that every airliner averages two lightning hits a year. Usually the only effect is a pitted fuselage however Uman displays his "friendly skies" photograph showing an arliner with a burned-off nose, one example of what lightning can do. In 1963, a boit hit a Boeing 707 and blew up the fuel tank in one of its winns. "The FAA and the airlines will avoid blaming lightning whenever they can " says Uman. "None of them wants it to be lightning because they don't want to be blamed for not installing additional heavy protection devices, but a fraction of wind-shear and other accidents are

WE DON'T KNOW HOW LIGHTNING ATTACHES TO THE GROUND AND NOT MUCH ABOUT HOW IT GETS FROM THE CLOUD TO THE GROUND—MAINLY WE DON'T UNDERSTAND ITS BEGINNING AND ITS END.

really caused by lightning."

Meanwhite, auminum isostages are giving way to physically conceater, Metal fuselages are good conductors, because highling runs through the airpland's skin, not to vital organs. Composites, however, are poor conductors, putting a plane's imands at not. Enposites, towever, are poor conductors, putting a plane's imands at not. Enposites, towever, are poor conductors, putting a plane's imands at not. Enposites, towever, are poor conductors, putting a plane's imands at not. English and the state of the plane of the state to the plane of the state of the state to the plane of the state of the state to the the state of the state o

Even so, experts the Uman acknowlodge that much of their understanding of lighting is still tentative. One reason is that truly modern lightning studies are relatively recent, having begun with NA-SA's lunar program. "Apollo 12 was the start of a lot of funding for lightning research." Uman save.

One minute after Apollo 12 lifted off on November 14, 1969, it was roaring through clouds at 6,000 feet. Launch controlliers were complacent because the clouds hadn't been producing lightning, and it had generally been assumed that when a rocket or aircraft was hit by lightning, it had simply got ten in the way of an oncoming bolt Researchers studying the Apollo 12 Incident, however, discovered later that the 360-foot rocket had triggered lightning. A bolt bit it. Seconds later, at 13,000 feet, it was hit again. Fuel cells powering the command module temporarily disconnected; so did the inertial guidance system. Instruments measuring the rocket's skin temperature and its fuel levels blew Luckly the astronauts were able to reset the equipment and continue on to the moon. Why did the discovery that arborne vehicles could trigger lightning come so late? "Fafure to recogrize the obvious, not uncommon in the history of science," says Uman

NASA's newfound respect for lightning notched upward again in March 1967. An ummannad Aliss-Centaur rocket whooshing up from Kennedy Space Center with a \$160-million communications satellite aboard triggered a light-

ning hit. The currents scrambled the rocket's electronics and sent it tumbling. Air Force range safety managers on the ground had to blow it up.

Then, in June 1987, at NA-SA's Wallops Island, Virginia, facility, lighting sizzled down and ignited three unmanned rockets sitting on their launch pads. Two roared off into the czone and the third silthered along the oround into the sea.

Such mishaps got NASA's attention

Besides, Florida-space-launch headquarters-has more lightning than any other state. Humid breezes blowing in from the Atlantic and Gulf of Mexico make Florida the nation's stormiest state, with thunderstorms billowing up almost 100 days every year. After the Apollo 12 Jaunch, Kennedy Space Center became a major site for lightning studies. Scientists converged at Kennedy to study lightning physics, such as the currents in the strokes and the surrounding electromagnetic fields. They also developed new lightningdetection systems, which are now pperational at Kennedy. Some are in commercial service, available to anyone, others are still emermental

Another subject of scrutiny is triggered highining—the kind that nearly wiped out Apolo 12. The aim is to provide mission controllers with data on when to go ahead with a launch and when to scrub it. Researchers have sent up hundleds of test rockets trailing wites, throug to determine the strood phene conditions in which aircraft and rockets trigger flashes. They found, for instance, that a rocket is more apt to trigger lightning when a thunderstorm is relatively inactive or in its death threes, seemingly electrically drained

NASA's needs are not the only reasons for launching test rockets into thunderstorms. Much of what modern scientists have learned about lightning has come from scrutinizing artificially induced lightning. Scientists can trigger lightning with a wre-trailing rocket, making ersatz lightning much easier to study than Mother Nature's own. But natural and artificial lightning aren't necessarily identical. For instance, natural lightning flows down an ionized channel in the atmosphere-in effect, the air becomes a phantom wire. Bocket-tripgered lightning flows down the rocket's trailing wre in its bottom portion, vaporizing it in the process. But, Uman says, the ionized channel of a rocket-trigdered lightning stroke has primarily similar electrical characteristics to that of a natural lightning channel.

Besides launching rockets into storms to compare triggered and natural lightning, scientists have probed lighning by taking photographs of strikes, and ther ficking instruments have recorded boxfus of data—much still unexamined—on lightning's electrical and magnetic fields, its radio signals.

"For fifteen years at Kennedy, the University of Florida research was housed in a semitratler with antennas and camora ports," says Uman, "Then NASA dedicated a building to lightning researchers." The research paid off. As a result of what they learned in the Kennedy studies, scientists have gotten better at predicting and detecting lightning. Kennedy is now dotted with antennas that measure atmospheric electrical fields. Controllers draw on that data when deciding whether to go ahead with a launch Recently, for instance, the shuttle Endeavor sat on Pad 39B at Kennedy-in its bay a tracking and datarelay satellite. The countdown was on hold for a weather check.

Thousands of citizens had driven onto the cataleway south of the pad to watch the launch of mission STS-54, their license plates from as far away as Guarn. Through binoculars, the spectators could see a lightmng-protection mast shoking bin from the launchtower, but they couldn't see the launchweather-team monitoring instruments métôring the data against a gofro-go checkiat.

The checklist requires scrubbing a launch for a long list of fightning-relat-



fight back and get a government contract to clean it up."

ed resons. For instance, if within 15 minutes of the launch lightning flashes within ten naulical miles of the paid or flight path, ifs no go it's also no go it the rocket will be passing through obuds more than 4,500 feet thick, where temperatures are between freezhing and -4 degrees Fahrenheit.

While STS-54 sat on its pad, the controllers plodded through their list Would the rocket pass through "an opaque cloud that's become detached from a thunderstorm?" If yes, it would be no go, as it would be for a flight path through cumulus clouds colder than 41 degrees Fahrenheit. The launch would be delayed if the rockel passed within five nautical miles of clouds with tops higher than the allitude at which temperatures drop to 14 degrees Fahrenheit or if instruments measured electric fields averaging 1,000 volts per meter within five nautical miles of the pad.

Because of such tightning criteria, about 45 percent of all summer atternoon or evening shuttle launches must be scratched. But mission 1576 44 was lucky The voice of Mission Control come over the loudspeakers. "We'll give Endesvor and her crow a chence oncoded" The shuttle silently function to oncode the shuttle silently function. To the sonosphere, followed by its roar. No lightning.

The warning system had worked again, but skeptise still work, in 1992, money-short Kennedy Späce Center abruptly canceled most of its lighting research. Some scientists fear they still know too title ebout lighting to guide insets that fockly spino-go guide insets that fockly spino-go guide are sufficiently sinct and that current detocion systems are adequate.

At fighting-research centers like the University of Florida, scientists continue to probe Earth's amperes and volts, and Uman says cloud technicians refined a, theory of how clouds become electrified that's now accepted by about 70 percent of the researchers.

Instrumented billeraft that fly through thunderstorms, sniffling out plus and minus regions, have verified C. T. R. Wilson's suggestion of 80 years ago A thunderhead is positive to lise upper regions, negative lower down Most researchers now explan bown and gravity-driven (to particles that bump and rub, in the process losing or gaming electrons

Losing or gaining electrons leaves any atom electrically charged—an ion. When atoms (see electrons (which are negative), their positively charged protons dominate and so filey become postive ions. When atoms gain electrons,

CONTINUED ON PAGE 80





Article By Valerie Govig

POWER

The sport is still very, very new. It has no teachers, no schools, no competitions Drawing By Ori Holfmekler

nota i an a minera



"Wear a tight swimsuit," says Sue Taft. "You can get pulled out of it, and there's no going back!" Sha's taling about body surfing with a controllable kite, which anyone can do with no equipment investment other than a kite and a swimsuit.

She and her friend Lee Sedgwick, both of Ene, Pennsylvaria, will try any kind of rice behind a kite. With eight years of practice under their beits, they are the foremost excer-

menters and leading enthusiasts in the sport and passion of kite propulsion, or tractom-which some people call wind salling, worrying that the word kite will be misitianpreved as kids fall. Taft and Sedywok enpy all forms of the sport, but their favorte surface is ico, which gives the silckest ride. Winds? I cleally, 14 to 18 miles per hour, but the usable range is 5 to 50.

So where would you expect to find them on a cold winter weekend but on deen-frozen Presque Isle Bay next to Lake Erie? And they aren't alone. "We usually have ice on the bay from the middle of December through March." Taft says, "and eight to ten people join us about three out of every four weekends." Beforehand, the phone lines are hot along the network of onthusiasts keeping tabs on weather conditions. Presque Isle State Park, a peoinsule that juts out into Lake Erie, encircles a ventable ice rink in the winter and offers great summer sites too including beaches and dunes in all directions and "the greatest sunsets in the world."

Gainy Courts, one of the best filters in the group, is demain on ice today He stops for a minute to crow about how great the winds are, leton hin jump and thum in freeform mode. "You can do anything," Courts says. "There are so many ideas going on in this sport—combining kite and personal arcohatics, setting speed and distance records, and synchronizing team shows to music.

From the shore, the kide skeys make a paped/u score as they glicit back and paped/u score as they glicit back and forth acress the bay Bai out on the key can base the challenge in the holter, "The page faster than you and". While there's no formal racing in the sport yet. Sedyack says that in two of these years the racing will come: "It will push the sport, and the number of entitualests will double," though he claims ne's into fi'l.

Pay was not the isses when ixto intocino togan about 4.000 years ago. Then, it is said, khos purposefully pulled whoeld vehicles across the Chrina plains. We know this loss propelida cances in Samaan the eligitizenth century But the preme ancester or kike traction must be trial crazy automateche Cancel Placott of Wates), Chrighten, who is schoolteschet Gescher Placott of Wates), Chrighten, who is private lead cancel and the kite and cancel and the set of the Friench exercised and the kite and cancel for carraige) was a buge outor. gy pulled by kites flown on four lines. Poccok's repeated system allowed him to carry up to five passengers at a time around the countryade, pulled by kites, at speeds up to 20 miles per hour. One story tells how Poccok evaded highway tolls because the rate of pay was based on the number of horses pulling the carrage No horses—ho fall.

But even Pocock would be amazed to see what's hap-

pening today. The new wave had its orgins in start Mass, the dual-inters (flown from two lines) that became popular in the late 1970s. Maked of "space-agi" materials such as rpsitos synthetics and graphtics pars, they were durable encugh to be flown and flown again, to be practiced with You could hone your kieffying skills, and kite entitusests did. They made kiting an active sport.

Naturally enough, some of the kites were made big enough to take you for a ride, and this became less by accident and more by choice as kiters would go riding down beaches or over fields, wearing out their speakers and leans. Soon the fliers went mobile and adopted skates, skateboards, and skis. However, they still faced the nuisance of having to walk back to the starting point. And kites lost their pulling power the faster the flier moved because of the lower apparent wind available. "Apparent wind" is a sailor's term. To the kite, the wind is relative. the kite "feels" more wind when it's mov-Inc. But if you, the filer, are the kite's anchor, and you are moving, you reduce the kite's movement relative to its anchor. The faster you move, the more you reduce the relative wind at the kite. The kite, therefore, won't pull as strongly, say, when you're moving as when you're standing still

Now high-leach solutions have ended these problems Equipment is readly available in kille and sport stores. Consequertly, there are today probably 2,000 people hauling themselves around by kits whon five years ago there were virtually nonsodynavic. Tart, and friends are pushing the limits every chance they get—on gress, hard ground, sand, and weter

Sedgwick has used grass skis, the catorpillarlike skates that are made in Europe (about \$125 in ski and sporting-goods stores) They work well in good winds, 15 miles par hour and steedy On parking lob or smooth, empty highways. Sedgwick and

Tait got a good ride from skates, both regular and in-line (Rolebitades). On and, down'his does or sand skas are easy to use, but because of the greater findfon they present undontoi, you need more power—put hat some from your hife and the wind. An increasingly capital choice for wide begingowerd, and the start buggy. The wide begin like a way howe-of-bar during bar wide bar wide begin like a way how-of-bar ground skel trayche that you steer with your feet communities.





The first thing Beizer did after hearing he was going blind wis to buy a camera.

He knew nothing about photography other than he liked a good picture as much as the next guy Once in a while he'd see one so starting. original, or provocative that it would stop him and make him gape or shake his head in wonder at the moment or piece. of the world caught there But beyond that he had given it little thought. That's what was great about life, some neople knew how to take pictures, others build chimneys or train poodles Beizer behaved in life. He was always grateful it had allowed him to walk in its parade. At times he was almost dangerously good natured. Friends and

acquaintances were suspicious. Where did he get off being so happy? What secret did he know he wasn't went into the store an telling? There was a story point around that when Beizer discovered a letter his don't know about this oritriend was writing to a new secret lover, he offered to huse her a ticket to this man idiots. Something I so she could on visit and find out what and know it's doing was going on there His said he wanted her to be happywith or without him. But now things would changel God or whoever had decided to'give Norman Beizer a taste of the whin via this blindness. Eriends were all sure he would change for the worse, start ranting and shrinking into self-pity and and up like the rest of expert shruggers, look

ing for the answer in

this camera. A real

tomorrow Instead he bought

hang of it and their beauty too-a Cyclops 12 Since he you're on your way." didn't know anything Beizer did something about the art, he strange. He nicked the camera up and, admitted ident. That's what he told the salesman "Look. I stuff, but I want the best camera you have for absolute. can cont and shoot all the work." The salesman liked his altitude, so instead of offering a Hiram Quadola or a Vasiov Cyncrometer, the kinds of cameras used by strict Germans to do black-andwhile studies of celebrities' nases, he put the Cyclops on the counter and said "This one. It'll take you an hour to get the

holding it against his chest, said, "Are you telling me the truth?" When was the last time a stranger asked you that question? The salesman was fieldbergasted. His job was lies and false zeal, takes and passes behind his back. He had toki the texts but this customer wanted him to say it. out loud, too. "It's the best for what you want Try it a couple of days and if you don't like it bring it back and well find you something else." The problem with the Cyclops was it was exactly what Beizer had asked for it took as hour to read and understand the instructions he had shot his first roll of film and had

it developed The pictures were as precisely focused and uninteresting as fastfood hamburgers Everything was there. he'd gotten what he pard for, but a moment after expe riencing the picture he foront it. The first of many revelations game to him. How many thousands and millions of times had certain things since the advent of the camera? How many times had peo ple amed at their pets, the Effel Tower the family at the table? Walking around the house one day trying to think of interesting and artistic things to photograph. he got down on his knees in the bathroom

through the glass shelf it rested on. That was pretty clever, but when he saw. it developed, he frowned and knew at least a few hundred thousand people had probably had the same idea in one way or the other. Out there in the large world were drawers full of photos of toothbrushes shot "artily" Worse, other neonle had had to take the time to fix their shutters and set the speeds because cameras had never been as apphisticated as they were now Now they were point, shoot, baf, you've got your toothbrush. But back whenever. one had to think, adjust and figure out how they'd get that shot. There was process and careful thought involved.

While this played across his mind, he heard shouts through the open window and realized kids were having fun in the park across the street. Their calls were wild and screechy and he thought, If I were going deaf, how could I preserve those great sounds so that in my silence I could somehow remember

them exactly and know them analin? We're all aware that in the end the only thing left is our memories, but how do you preserve them when one part of you decides to due before the rest? He realized he had bought this camera so he could go around seeing the world he knew for the last time and in so doing. perhaps teach his memory to remember. But that wouldn't work if he had a mindless genius machine

that did exactly what he told it to but gave him nothing of himself in return. It was like those exercise mechines with electrodes you hook up to your body, then he down and rest while electricity makes you thin and muscular

He went back to the store. When the salesman saw him again he was almost afraid Beizer decided to tell the man everything. About the blindness, about his need to find a camera that would not only do what he told it, but teach him how to see and remember as well

As he walked to the counter, the thought came that whatever machine he left with this time, he would use a week to learn its principles, then allow himself to take only ten pictures before he put it down forever. The doctor said he had about three months before the disease marched across his vision dragging a black curtain behind it and then that would be the end. In the ninety days he had left, he would try to learn and consider and achieve all in one Ten pictures. Ninely days to take ten pictures which, when his sight was gone, 64 OWN

would have to provide his empty eves with what he had lost

The salesman heard him out and immediately suggested he go to a store specializing in books of great photography "First look at books on Stiegitz and Strand. The guys in the Bauhaus School: They were the masters. That's the best way to start. If you wanted to learn how to paint, you'd go to a museum and look at da Vinci." "It won't help. I'll look and maybe see some great stuff, but that won't help me remember. I don't even want to remember what they" Beizer held his hands up to the sides of his head as if showing the other how little space he had to fill there. "I don't want to learn how to paint or take pictures. I want to remember my sights, not theirs. And I don't have much time left "

The salesman shrugged "Then I don't know what to tell you. There are two directions to take. I can rive you a child's camera. The simplest thing in the world, which meens you'll have to do

THE BLIND MAN BROUGHT THE BILL TO HIS NOSE AND SNIFFED IT. IT WAS MONEY, HE WAS SURE OF THAT MAYBE EVEN TEN BUCKS WHY NOT? THE WORLD WAS FULL OF LUNATICS, WHY NOT THIS ONE?

> all the work. When you want to take a picture, the lighting will have to be perfect the focus, everything will have to be there because the camera won't do anything for you but click: just the opposte of the Cyclops which does evervithing. The other way is to buy a Hasselblad or a Leica, which are the tops. But it takes years and thousands of pictures to figure out how to use them. I don't know what to tell you. Can I think about it some more?" Beizer left the store empty handed. But for the time being perhaps that was best, having the right camera meant he'd have to begin to start deciding. In this interim without one, he could do around looking at the world, trying to choose

> A few blocks from home, a man sat on the street with a hat turned over on his lap and a hand-written sign that said. "Lam blind and heartbroken and have no work. Please be kind and help me." There were a few brown coins in the hat. "Are you really blind?"

The beggar raised his bead skyly and smiled. He was used to abuse

Some people taunted him. Now and then they'd ask stupid questions but then give him money if they liked or pitled his response. Before he had a chance to answer, whoever stood above said, "Tell me what you miss most about not seeing and I'l give you ten dollara

"Fried chicken. Can I have my ten dollars, please,

Beizer was stunned but went for his wallet. "I don't understand ! He handed over the money.

The blind man brought the bill to his nose and sniffed it. It was money, he was sure of that. Maybe even ten bucks. Why pot? The world was full of lunatics. Why not this one? "You know smoking? A cigarette is three thingssmell taste and sight. You gotta see that gray going out your mouth and up in the air to really enjoy a cig. I stopped smoking about a month after I went blind. I know puvs who can't see but keep doing it, but it's a waste of time, you ask me. Same thind's true

with fried chicken. Taste it. - smell, do all that, but seeing it's most important. The way that gold skin cracks when you cull it apart, the smoke coming up from the pink meat underneath if it's just fresh, then the shiny oil on you finderfips after you're finished ... Don't get me wrong. I still eat it, but it isn't the same. You gotta see to really eat it

Beizer dave him another ten dollars, and went right

home to write that line down: "You gotta see to really eat it." A week later, he found another in a book he was reading on photography. "The celebrated painter Gainsborough got as much pleasure from seeing violins as from hearing them."

Somewhere in the land where those two ideas lived was what he sought and Beizer knew it

The arifnend called, having returned from the romantic trip he had paid for. "It didn't work. Know what he did, among other things? Sent these incredthis love poems I thought he'd written specially for me. Turns out he only copled them out of an anthology he kept from collecte

"I'm sorry I haven't called, What have you been doing?"

'Going blind."

"Oh my God!"

They spoke a long while before she said cently, "Honey, you can't do photography when you're blind."

Actually you can: I heard there's a whole bunch of blind people taking CONTINUED ON PAGE 87





TO MAKE UP STORIES THAT EXPLAIN THE MYSTERIES OF THE UNIVERSE IS

THE WORK OF HUMANITY. TO CREATE A SCIENTIFIC VERSION OF GENESIS,

BUILD INSTRUMENTS TO HUNT FOR THE HALLMARKS OF CREATION, AND

SUCCEED IN FINDING THEM IS THE SPECIAL PRIVILEGE OF COSMOLOGISTS.

PHOTOGRAPH BY STEVEN ROTHFELD

INTERVIEW

I have reached back in verse We have lauhched a little space probe to receive the fart whise parts of the cosmic explosion of fiteen billion years ago, and we have measured the shucure of the GB gang rise's least than a fraction of s second after the universe started to expand."

Leading the team that made viatal Stephen Hewking calls "the decovery of the century, if not altime," cosmologist. George F. Smoot announced the stunning breektrough at an Amenan Physcal Society meeting in April 1992. After 20 years of manacola attention to detail in validaring experimental results. Smoot, 47, subdenly found hinsel calapulled to stardom

bookshelves (guardrailed for earthquake safety) in his office at the University of California's Lawrence Berkeley Laboratory, Smoot's face is flanked by two computers on cluttered tables behind him. A little laptop that accompanied him on a recent trip to NASA's Goddard Spaceflight Center perches between the larger machines, downloading into one parent's hard drive. Smoot talks in rapid-fire bursts that leap from one idea to another like electrical impulses. His great boorning laugh is amplified by his large frame and the abandon with which he surrenders himself to the humor in the moment. His thoughts turn repastedly to the time when all matter and energy were crutched into an almost infinitely hot, infinitely dense point before rushing headking into the inflationary expansion that has created this universe

Amenican astronome Edmin Nico le gathered the first evidence in the "wenthes that the universe was expanding "When he observed the distinit galaxies moving away from us at prodigious speeds, they looked to this (bit they'd been oxpelled in some primordial exploion—if ther tight path could be run beckmard, they would all cosileous into the anging finefail. Belgian cosmologist Georges Lemaître first voced the idea of a "primeval atom" in 1927. But he theory got its enduring name the Big Bang—when English astronomar Fred Hoyle, who balewed the universe always had and always would exrist in a "steady state." derided the sudden bith notion.

Smoot was a boy in Florida when socientatis began amaking support for the Big Bang. The theory made good pricitores about the abundence of hydrogen and helium and explanand why the sky in dark at might Flery startight must dim and cool in an ever entraining occunos where sites are born from gravitational colapse and later dim. The Big Bang also might the existence of a fams afterglow of radiation, a reac of the original exolection.

Scientistis in 1948 suggesteint hit 15 billion years ago, the oceanic background radiation must have been umanginatily hot. But spreading liseli thin in the intervening millenne would have hardred to to famt writeper of lowenergy microwiwes far colder than too have backed to the Panzase and Robert Wilson at Belt Labe acculationally detect out, dentified, and measured the temperature of the low-energy microwaves at 273 degrees above absolute zero.

The smoothness of the osemic background radiation recalls the time when the universe was as uniform as homogenized nik. Today, in contrast, it is awfully timey; broken up into people, planes, stars, planies, clusters of galaxies, and giant walls of superclusters surrounding gant vicids. The costmic background radiation, then, carries out beel key to the datant past.

People had been probing the cosmo beckground radiation for 30 years, but no one had detected any deviation from absolute smoothness, po hint of the beginnings of the shucture that dommakes the present unveste—no one un-



NOW WE WANT TO MAP IN DETAIL THE STRUCTURE OF GALAXIES AND SUPER-CLUSTERS OF GALAXIES.

til a team headed by Smoot detected variations in temperature measured in millionths of a degree. These minuscule differences show the ripples in spacetime where matter first began to clumn gravitationally about 10,000 years after the Big Bang, Radiation from regions of higher density expended more energy trying to escape a deeper gravitational well and therefore appeared slightly cooler than average. Radiation from regions of lower density retained more heat. Smoot's team charted these differences in radiation from detectors aboard the Cosmic Background Explorer satellite, or COBE (rhymes with Dobie)

Over-happed maps in shades of prive and buic occurs Brondro blice, dipplicing for pattern of temperature fluclutions across the hereins. All holps of and gay as anomnous Easier cogp, the maps summates buicked using the finite year in order. They represent a heroursen task of data analysis to decome the pattern in the walker of most and to angle out that pattern from overdation emitted by our Mink Wag using any and the motion of Earth, solar sysany and the motion of Earth, solar sysm, and using about Provide State 1990. In the efforts to validate hits results before amouncing them, Smooth thed to imagine every scenario that might have datoriated the data. Unable to see anything wrong, he offered a pair of plane takets to anythere in the world to the team member who could uncouer amissiau in much do in representation, a missiau in much do in the plant to the ADBE team world by the plant of you're religious, "and Smoot at the press conference after the formal annuncement," "its files seeing God."

-Dava Sobel

Omni: What possessed you to use the G-word when you announced the CO-BE findings?

Singet: Invoted God because it's a caltural icon people understand—but there's something deeper Taking ing the connector to relegation. In all rebased cosmology, you can't help making the connector to relegation. In all reters from religous people. About half said, "Ther's great. It's wonderful whell as the test remer religous people. About half said, "Ther's great. It's wonderful whell as the test makes severe meths. You don't need these severe meths. You is another the the Babia."

Even so, few letters were antagonetio. Most entroism came from scientists who find the idea threatening because it's an unresolved issue personally. To get into second, a to d'scientists may have rejected religion initially but then later never went back and got comfortable with this rejection

Ommit Ware your parents religious? Smoot: They were Protestant—not strongly religious, but we went to church when I was young Anyway, I'm contortable with it

Omni: Did the public's response to your version of creation surprise you? Smoot: Yes. I thought the finding

JOB TITLE:

Professor of physics, University of California, Berkeley; researcher, Lawrence Berkeley Laboratory

RECENTLY WRITTEN:

Winkles in Time, with Keay Davidson (Morrow 1993)

TIME IN HISTORY HE'D LIKE TO WITNESS:

One millionth of one second after the Big Bang

GREATEST ACHIEVEMENT:

Led the team that discovered evidence of the universe's earliest structures

ON THE BIG BANG AS A CREATION MYTH: "It's a great core.

vertect for the modern world because it's gitzy and high tech."

SWEET SMELL OF SUCCESS:

"I know the secret of the universe."

FUTURE QUESTS:

Detection of gravity waves and dark mailtor

ON DARK MATTER:

"In cartaons, you see people standing out in the middle of nothing. They could be standing on dark matter or running off cills onto dark matter."

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would appear in texts and popular books on cosmology and only them leak down to the media. But it drew tremendous attention—and it was good news. In science, the news is often that something avriul has happened.

Omni: Who clirectly influenced you? Smoot: Enrico Fermi has been a hero since MIT. The teachers who influenced me directly were themselves taught by Fermi As postdocs at Berkeley, a bunch of us would lunch with Lors Alvarez, Emilio Segrè, and Owen Chambertain, who had all known Fermi and all won Nobel Prizes. They used to love to give us war-story guizzes on probiems in nuclear physics they'd faced. Sometimes we managed to figure them out. Nowadays, you don't learn much nuclear physics: it's out of fashon Particle physics, cosmology, astrophysics methematical topology-these are where people think the frontier is

Omni: Where do you place the beginning of modern cosmology?

Smoot: When I was a graduate student in particle physics at Brookhaven about 20 years ago, scientists were diecovering that the proton is made of quarks. They'd tried to measure the diameter of the proton accurately but kept finding it to be soft and mushy with hard points in it. We now know protens and neutrons are both made of quarks, and so their collision may involve two quarks in each particle, or there project a set clear, there pojewe barnes between them colligges, so one can imagine protons and neutrons colliding and succently dissolving into a burch of pointilles particles whose interactions get weaker and weakreas you push them together.

Well, suppose everything in the universe consists of pontilse quarks with no finite extent, and the more you push them together, the less they reset? Then there's no limit to how many you can get och the head of a pin. The difference between protons and quarks could be infinite—which fits much batter with the Bg Barg model's implication that you're manufacturing spacetime. The suitcase expander untods and you're got more suitcase.

Ovani: How does inflation fit into the Big Bang theory?

Smoot: Inflation is the engine that drave the formation of spacetime. The inflationary model holds that a small region of the early universe—say less than a millionth of a millionth of a proton—expanded in a tiny fraction of a second, faster than the speed of light, to something about 100 meters in size.



Omni: Faster than the speed of light? Smoot: Things moving apart faster than the speed of light don't actually move, the distance between them just has to grow. The only thing that travels faster than light is spacetime. Essentially all the spacetime we're in now was created during that tiny fraction of a second. Tiny fluctuations, guantum mechanical effects, got stretched to sizes of cosmological consequences. These small fluctuations from the origin of the universe are what have drown to be dalaxies, clusters of galaxies, and the larger scale structure we observe today. Inflation is a transcendent concent linking the very small and very large

Omni: It's said that the COBE findings unified astrophysics on the largest scale with quantum physics on the smallest scale.

Smoot, That was the tend of oscindloby anyway, ODE just found the pioces and put them on a tim observational foundation. With the ODE data so strongly supporting the Big Barg, werybody tells quick on/fident But the Big Barg taget is what ultimately makes the connection between astrophysics and particle physics, because if you go back far enough, space gats densar and hoter until eventually you're having particle interactions

Omni: Particle interactions?

Smoot: You don't have particles at the beginning, just this stuffed-in, energydense space that's going to turn into particles, energy, and present-day space It doesn't seem unreasonable or outrageous to me now that I've gotten used to thinking of space as flexible, stretchable, and having real substance. It's a real thing on its own. Energy-dense space can turn into the space we're used to, and particles. I think of it as a metamorphosis, like the difference between the caterpillar and the butterfly You wouldn't think butterflies and catemillars were related until you noticed that one want into the coccos and the other came out. Well, particles and space are not so distinct anymore.

Omm: We imagine at the moment of the Big Bang that matter began shooting into this vast, empty space from some dense, central starting point.

Smoot. That is the general misconception, but a to goes on in what we thrik of as empty space. The Big Bang (desrit expand two space) it is space. Space ited expands, and as it does. It increases the distance between miltor that was once densely packed. One can poture the expanding universe by thinking of galaxies as dots drawn on a halton. As you blow it tup, the galaxies II yapert in all directions, but Tis really the increasing space tod' that widens the distance between galaxies. I can't emphasize enough that space is what's expanding, not the galaxies moving out into space.

Inflation represents the extreme case, where snace is not only very flexble, but also has the ability to warp and expand. It can be deformed both in its curvature and scale. During inflation, snace has a lot of substance in terms of energy density. Now imagine that the energy density puts ripples in space Where the curvature of the ripples is costive, particles will eventually converge, the way lines of longitude on a globe converge at the poles. If you take ripplas of all different sizes and scales. you'll end up having particles converging on all different sizes and scalesthe stars, galaxies, and clusters of galaxies Where the curvature is negative, narticles will flow away leaving voids.

You're creating all the space. There was essentally nothing there. Haven't resolved this, but I think of space and time as complementary, but time is roally different from space. I advays hated when people taught me'n spacea relativity that time and space are the same timg, because they're obviously not. You can rotate an object in spacea, but if you try to rotate it in time, you have to made off space and time in a funny way. When we try to calculate what a rotation looks like, instead of keeping the distance constant, the spetial distance grows or subtracts.

Somehow I've crunched everything down to virtually nothing. Then I start unfolding space and time and trade them off. When I get a little space, I get time; more space, more time. This is a tricky picture because of this concept of space having these intrinsic properties of curvature-that it can change its curvature and stretch its scale and trade it off for time. The ratio of tradeoff for spacetime depends on the curvature, which riepenris on energy depsity if you make the density just right. then the curvature of space is just right, so the unfolding costs you zero So it's funny: you're creating space and all the energy in it and doind it for no cost. That somehow violates your common sense. But you couldn't collapse it all back down---right?

Omni: Have you other mental pictures of the Big Bang?

Smoot: My laverite analogy is an infinite petri dish full of rapidly dividing cells. If a cell mutatas, it makes many smillar cells around it, so the infinite petri dish has regions that look different from each other because of local mutations in one area, a red-mutationg cell creates



a growing blob of red ceils Around it are white or clear ceils, and over there's a bunch of blue ceils. The regross made early grow big during the inflationary period because the expansion is accelerating. The distance between any two ports grows at an exponential rate. Regions made later can never get to be as large.

Omm: Do you have a visual image of cold dark matter?

Smach Wall, it's not there. It's a more advanct question like, 'How do you visualize strength or louchess?' I have not utices about cold dark matter I don't hink of it as visual, but ususannoon through metamorphoses, Irom energy density to ratation and particles. Durdensity to ratation and particles. Durtouosity wall particles by their gravtiouosity wall particles by their gravtionuosity wall particles by their gravtorming another the rate of the strength torming another. There were particles to mobarrowice dark matter.

Omni: Ordinany dark matter might include invisible things like burnt-out stars and black holes, nght? But nonbarvonic dark matter is fundamentally different from matter as we know #? Smoot: Yes. The early universe is so hot and rapidly expanding that nothing can clump together. But about 10,008 years after the Big Bang, the dark malter can start saying, "Let's pay attention to ourselves instead of the radiation " It can start clumping. The only kind of matter then is nonbaryonic dark matter, a non-light-interacting, ponelectromagnetically interacting material. The matter we're used to interacts with and generates light, so we can see it as stars. But nonbaryonic dark matter is free to follow the curvature of space earlier than regular matter and is very effective at forming structure.

It's astucture you can'tes al titraasthough an investible man were leaving his loopprints all over the place. Than whan the unverse cocks enough for matter that interacts with light to 1nally get released, at about 300,000 years after the Big Bang, the ordinary atoms collect in the tootprints like dast. The ordinary matter quokly dast the ordinary matter quokly ing to 11 in some skipped steps in the cold-dask matter model.

Omm. Hadn't you attempted to measure the background radiation?

Smoot: I started out by trying to detect irregularities—anisotropies—in it. I expected to measure something about the dynamics of the universe and thought the origin of galaxies was a trivial problem Galaxies were there, obviously, and must have formed from tumps, but

CONTINUED ON PAGE 93



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ANTIMATTER

THE SPIRIT OF BARBIE

We've all heard about people who channel entates alleged from beyond. But only Barbara Bell, managing editor of the New Age journal *Common Ground,* channels Barbie.

Two years ago, Bell noticed a dozen of her four duqthers' Barble dols scattered across the floor of her San Anseimo, California, home. "I thought, What does this poped full thirk?" says Bell, "and Barble's voice just popped into my head, saying. I'n ead respect."

Hearing of here experience, Bell's colleagues Hearing of here experience, Bell's colleagues Suggested she channel Barbie. So Bell started the lettrie / Channeling Miwrslettrie / Channeling Miwrslettrie / Channeling Miwrslettrie / Channeling Miwrslettrie / Channel Michael Michael (Channel) (Channel Michael Michael (Channel) (Channel Michael Barbie, "and the words Barbie, "and the words Whode inclination is also Barbie," and the words whode inclination is also Barbie, "and the words whode word with no voice that's real."

Mattel, however, thinks the corporate voice of Barbie is doing just fine. "We feel that this use of our trademark adversely affects the family image," says Lisa McKendall of Mattel.

Bell, however, says



she's doing nothing wrong, "I'm not selling anything to little kids," she notes. "I'm writing about adult concerns and giving Barbie a broader market. —Anita Baskin

Had a UFO experience? Want to talk about it? Call (900) 285-5483, and give us the details. Your comments will be recorded and may appear in a future issue. For moredetails, see page 80.

END OF AN ERA?

Still wating for your first UFO sighting—a nighttime disk, pentaps, or a organ-staped craft hat leaves tracks on the lawn? If so, asys mexitigator David Jacobs, you're living in the past. The wave of the future in UFO recludes nothing first man chudes nothing first hard a systematic study of the thousands of people boonkdrapped by alengboonkdrapped by alengbashdrapped by alengJacobs, who teaches history at Tempie University in Philadolpha, says UFO rosearchers have aiready used hundreds of thousands of cases to classify UFO movement, color, sound, shape, and impact on the environment. Foul how much verification do you much verification do you much verification do you much verification do you maker any of the why questions, like why are the schings taking place?

 But Jacobs views are called into question by Jerome Clark, vice president of the Center of UFO Studies in Illinois. "UFOlo-

ARE RESEARCHERS WHO CLASSIFY UFOS BY MOVEMENT, SOUND, AND SHAPE WASTING THEIR TIME?

gy is overlooking a treasure trove of information by neglecting sightings," he insists. "The more you back away from that sort of hard data, the more you get into speculation."

 For instance, Clark recently examined a raft of UFO sightings in which crafts came within 500 feet of witnesses.
"There wasn't one little gray man," says Clark, "which raises questions about why abductees see them now."

SKEPTICAL SKEPTICS

Skeptical about more than just ghreats and UPOs? Wonder how much science thire really is behing cyonicsreally is behing cyonicsreally is behing cyonics in which the doad are frozen in hopes at critical and the doad are frozen in hopes at concerned about the proliferation of cutts? If so, you might want to check out a new group of critical thinkors, the Attachen 2. Californiabased ritemational Sequelics Society.

Founded almost two duntal Colleg history-ofscience protessor Michael Shermore, the group publishes the group publishes the group publishes the group publishes the agranery maganic Skapkc With a circulation of 8.000, the publication spansors monthly lections at the California Institute of Technology on topics from withchaft to historical devisitation at the any encomment

to restrict divestation of the environment. But how does the Skeptics Society differ from the world-famous Committee for the Scientifiic Investigation of Claims of the Paranormal, or CSICOP, based in Buffato Investigation of Claims Shermer is concerned, the older skeptics group and its publication, the circulation of 38,000, its list not skeptical environment.



"Unlike CSICOP, we aren't worried about riling people's feathers." he comments. "CSICOP won't touch religions, for example. And they believe science can't do anything about social issues like crime or war. But for us, there are no sacred cows—we should not be afraid to look at anything from a scientific noor to view."

a scientific point of rew, CSICCP wavefree director Bany Kar, however, exponits out that his group was bounded group was bounded being of the paranomal of fringe science. We never sait we could care the social illie of the world. The says. We investigate issues that can be fested scientically and empirically, not questions of faith. Shermer flasts down.

Shermer plays down competition between the two groups, adding that the world needs all the skeptics it can get —Sherry Bake

VIDEO VOYAGES

While cruising off the coast of Hawaii with her husband Ron, Mary Yezierski of Palmerton, Pennsylvania, recorded erupting volcances on shore with a borrowed camcorder. But when the Yezierskis watched the tape on their home VCR, static had oblirerated the static had oblirerated the static had oblirerated the static had soliterated the soliterate

PLAYED IN SLOW MOTION, THE RECORD SHOWED A MAN AND A WOMAN IN OLD-FASHIONED CLOTHES.

volcano and Mary and Ron instead heard the mumble of a male volco. "My friend Wanda, who had been on the trip, duped the tape onto an eight frack cassette," said Yzeireski. "She played it back and heard a man's volce say. Come next Thursday. ! will be relent. less." We played the cassette on my VCR and saw a man in oldtashioned clothes. We thought he was a ghost—a dead, lost sailor---who was coming back for us the next week."

The mystery was finally solved when one of the Yezerskis' friends saw the "ghost" on the family VCR: She recognized it as the film *Dangerous Liaisons*, depicted below, which she'd seen on HBO while the vacationers were in Hawaii.

Charles Decker of the PonnsyNania Association of the Study of the Unexplained is not sure how the movie got onto the tape. "They couldn't get HBO on the ship because there was no microwave receiver," he says, "but a satellite dish on the Island may have influenced the camoarder and recorded that brief segment."—Anita Basklin

Brain Booster Breakthrough!

The Amazing New Learning Machine™ Teaches You Foreign Languages Overnight, Reprograms Your Mind For Success & Launches You Into Virtual Dream-State Experiences

By Davie Spotts



T's called the LEARNING MACHINE? The first time I plugged my brain into it I was reminded

of the '30s scift classic Parinstic Plant. If you've never scen the move, an astronaut on the plant Krill discovers at incredible learn mg inchnology – a hdmet hooked up to a super sophesticated computtion of the super sophesticated computtion is a super sophesticated computtion is a super sophesticated computtion is a super sophesticated computdates and the super source of the discovery of the super source of the super source of the super source of the same and supervised as the super source of the super source of the supervised as the super source of the super source of the supervised as the supervised as the super source of the supervised as the supervised as the super source of the supervised as the supervise

After loading a Learning Disc" mto my CD player, J pushed play and this incredible voice methed me to lower my Light Shteld, I did so and a few moments there as armszing display of light began playing behind my closed eyelids, along with a knack-your-socks off 3-D audio soundtrack

Within seconds this light-bound combination launched my bein into another dimension of consolvments: A place where my much was likenily primed for learning. Where information and entertainment become blended. And learning is effortless and super issue. Within no time 1 was speaking French, improving my vocabulary, and reading at 400% my previous speed.

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LISTEN: Everybody knows that knowledge is power. But learning slow and boring. Now imagine putting on a digital headset and opering a wiskow dirxtly mio year mind. Like magic you pour new information directly into memory.

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You select a specially programmed Learning Disc in the area you want to study. Plug it into any ordinary CD player, then attach your Learning Machine" digital



Learning Olice work Inweagh any CD player, sunding a lightneound mobile into your Learning Riachine, which decodes and bomiturs for information into your mind.

headset into the headphone jack. Push play and a few moments later

your mind is launched into a pre-programmed learning) essain in a fan, almost effortless way, the Learning Disc lesson plan unfolds is to program and transfers the knowledge into your mind. It's incredible and extremely simple to corretae.

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Shield, and your Learning Disc fires an amazing lightsound matrix that instantly relaxed mind-state helps lock the new information into your memory.

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ELECTRIC SKY CONTINUED FROM PAGE 56

they become negative ions. Lightning researchers say it's the ionizing of ice particles that charges clouds positively on top, negatively lower down.

As Uman explains it, a thundercloud might tower eight miles high, updrafts lift water droplets from the cloud's warm base into its frosty upper regions. where the droplets freeze into finy ice slivers and lumps of hail. The lightweight slivers can float aloft on the winds, but the heavier hall falls. Descending, the hall bumps rising slivers. The slivers loss electrons, becoming positively charned as they rise. Meanwhile, the hall gains electrons as it falls, giving the cloud's lower regions a negative charge. Tension grows between the cloud's top and bottom. "The plus and minus charges want to get together so badly, it's as if invisible rubber bands stretch between them-an electric field " save I lman

Usually, the two charges do meet. A current rips through the cloud, visible as a lightning flash. However, whether the flash says inside the cloud or reachee the ground depends. according to current theory, on the height of the cloud charge above the ground.

A cloud's reservoir of negative charge extends unward from the altitude at which temperatures hit the freezing point. In the tropics, that point is so far above the ground that the cloud's charged zones interact mostly with each other. Tropical lightning is ten times more likely to stay inside the cloud than to hit the ground. But farther north and south, where air gets colder lower, lightning bits the ground twice as often as in the tropics. At least that's what researchers believe the data show A few iconoclasts argue that cloud-to-ground rates are no lower in the tropics, and some say that tropical lightning may carry more current than lightning in higher latitudes, possibly because tropical clouds are bigger

When lightning does ttain down from a cloud, we're act to see only a gragie straidwr, have revealed that those scennigy snigh his are usually many strokes, flashing so rapidly in succession that we see them as one When tightning tickers, we discover incividual strokes

First, the cloud emits an electric feeler barely luminous, that zgzage downward. Each zg is a 170-foot or so stretch of ionized air that lasts a millionth of a second. Then the leeler recharges and zags aheed. As this neg-



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alwely charged "slepped leader" nars the eart, positive charges below are so powerfully attracted that they rear up from overy grass blade and pine needle. If is invisible gather "parter snakes imakes contact with the "memile reading nor of these poetfive "gather snakes" makes contact with the three-mile-leng negative "boo constinctor" dropping from the clouds. In effect, the cloud is now wred to the ground,

With the invisible wre in place, a "roturn stroke" sizzes upward at up to a third of light speed. High currents make this stroke bright. The glow might be ten yards in diameter, but the actual core through which current moves is only about an inch across AL 50,000 degrees Fahrenhait, that core is nearly twe limes hotter than the surface of the sun.

If the doud slit has excess negative charge, a new "dart leader" night retrace, more or less, the lonzed path of the orginal atokes, thegeing the process anew. More dart leaders may follow. A "angle" fash of lightning may acually be 20 or 30 separate strokes, but usually three or four—all in a spit second. Our eye sees only a thicker.

Some scientists, including Barmard Vernegut (chrothing a Consultative of novelat Kurt Vennegut), have offered a countermercy of the best details became changed. They arheve details became change and the changed barticles from near ground tayeu, Unan says that he and most other es. Uman says that he and most other lighting researchers continue to put their bats on the standard mode), based on proceidanto that tome nace of the change thereing and the standard mode).

However it may finally turn out to be viggered, kylting is apparently not Imted to Earth NASA's interplanetary masions have produced evidence that lightning flashes in other planets' atmospheres, too.

Cameras on the Voyager 1 and 2 planetary explorers snapped pictures of transient lights on Jupiter that are likely lightning flashes. Vovager 2 detected lightninglike electrostatic discharges on Saturn and Uranus And the Pipnear orbiter recorded radio signals on Venus that might be lightning generated Right now, the Gattlea mission is enroute to Jupiter with a lightning detecfor inside. University of Arizona researchers and the University of Florida Lightning Lab helped Germany's Max Planck Institute of Aeronomy design the Jovian lightning detector, "It contains an antenna that records lightning magnetic fields and a light detector, and it will be dropped by parachute," says Vladimir Rakov, a Russian lightning expert now

at the Florida lab

When Galleo arrives at Jupiter in December 1995, it will parachute down its antenna, listening for telltale radio frequencies while two light sensors peer out through fisheye lenses. The idea is to verify that Jupiter has lightning and to probe its properties: What sorts of magnetic fields do Jovian lightning bolts generate? What is the frequency the optical characteristics of Jovian lightning? Basically, the idea is to see how the currents and electrical and mannetic fields of Jovian lightning compare to Earth's. "We have a twin brother of the Galliso instrument here in Florida to see what it shows of terrestrial intracloud lightning; that way, we'll try to make sense of the data coming in from Jupiter," says Rakov.

Even torreachia lightmig remans aen. "Actually, wo intow very title about lightming, assys Rekov. To learn more, Lightming Las bacentiss are forever sampling the tropcophere. Kes dogs and the right examplick, but can pick, but but deatoms from around the globel rive uses the right example." Rekovers and the right of the right examine. The arous areas the right of the right example, the right of the right of the right example. The robusches subty lighting by analyzing electric and magnetic by sense that lighting garnetice.

Some of their findings should have practical applications. Just recently, the lab discovered that 50 percent of Florida's lightning strikes actually branch out





and hit the ground in two or more spots. That means standard claim on the frequency of lightning hits—used for softting protection levels for power lines and other equipment—might be way off. The uny is still out, but such discoverise can have is major impact on the electrical industry. As Uman puicit, "Feo power companies, lightning is the number-one problem."

The lab also studies a special species called "continuous-current" lightning, in which the strokes are longer lasting and thus more destructive. The researchers have found that a large stolke followed by a short interval and then a small stroke ushers in a continuouscurrent stroke Why is sell a mystery.

One practical product of the joint nesearch between the University of Arizomant the University of Florida is currently r use nationwide—an electromapnetic delection system that spots light: ning sittlee as they happen across the continent. Tis now commercially available to anyone who needs to track the pait of lightmg storms.

To show how the detection system works, Uran points one of the lab's computers, which is holded to the system headquarters in liuscon, Artorna. This present upsplays a collared math. So the system of the system of the location of the system of the system of location of the system of Artorna physical E Phills Prider relies or 115 sensing stations across the or 115 sensing stations across the in the atmosphere's electromagnetic location, preview during strekes.

Power companies ston up. So do weather services, airlines, and forest managers "If you're a power company and you see lightning coming, you don't let your people go home; you disconnect some equipment in the storm's path, and you get your workers off the wires," says Uman Kennedy Space Center has a local version of the Krider-Uman detection system that delivers more pinpoint accuracy. It uses similar instruments to monitor electric fields in overhead clouds. But even the Space Center's system is crude compared to a new souped-up detection network Lightning Lab scientists are now developing at Kennedy

To show of the new system, Even Tromson a Lighting Lab researcher, turne on a computer screen chowing data from five robot electric-field sensors dotted around the Space Center "Loss of souldgies", the says, in the New Zealand accent. Computers crunch the supplies into overhead. "With its sysmic "size Thomson, "hot only (rive see where a stroke hits the ground, but also what's going on inside the clouds,"

Scientists have only a dm understanding of in-cloud hightning because clouds are opaque. Sending an airplane in to trugger strokes helps, but such artificial intracloud strokes arrolf necessarily the same as natural lightning "So this new system as the first aitempt to study the locations and physics of major discharge processes inside clouds," assy Thomson

The system already has revealed a new type of electrical field that appears early in the electrification of a cloud "These fields may be a great way to detect that a cloud is starting to electify." Thomson says. The new system has other practical possibilities, too. "Kennedy could use it for launch protection," says Thomson He points out that Kennedy's current detectors are accurate only to about 1,000 feet; the new system can detect lightning hits to within 100 feet.

At Kannady Space Center, Thomson's associate Red/s Micelus shows off one of the robot sensing stations awing prid abut the size of a swimming pool lade out on the ground and suppoing law address index the automation ber optice cables hold: the automation instrument board of the notion instrument board of the sensing micelular avoids on various anonghitming projects for I-NET, a AVSA contractor, but the lightning-detection network adds automation to his workday.





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"Snake boots," he says in the comtrol trainer, hording up thuck learther Weilingtons. "We pet a tot of ratilesnakes and water moccasms, and the other day we hand Mom widh nog. Dad wild hog, and all the piglels." In addbon to his boots, he says, he huys mosquite repellent by the boxful. One day he was running slong the dirt road near the control trailer and skidded to a stop in front of a 14-foot aligedor

Medellus is a fan of the new system It's so sensitive, he says, that it can detect lightning strikes 120 miles away in Tampa, When it's operational in a year or so, it NASA maintains funding, it should help researchers answor some burring questions

We don't know how lightning gets started in clouds," says Uman, back at the Gamesville, Florida lab, ticking off science's points of ignorance. How do airplanes and rockets trigger lightning? What are the exact differences between natural and triggered lightning? In what kinds of clouds and under what meteorningical conditions can lightning be triggered? What is the mechanism by which the leader of a lightning through the atmosphere to the ground? Uman sums up the ignorance gap "We don't know how lightning attaches to the ground and not much about how it gets from the cloud to the ground-mainly we don't understand its beginning and its end *

Lightning is godfke "It keeps the earth negatively charged--we don't know what would happen if it stopped," says Uman But lear of lightrung is "imprinted in our genes."

Perhaps for good reason. Every year, in the United States alone, lightring kils more than 200 people II almost kilsuf Uman. He was oatdied during a lightning storm at Kennedy Space Center, holding a imcrophone and idicating his observations to offer scientistis make the research trailer. Acturghy, he was dealened by a cashbenything bocame intersely bright. "I went down those statis as fast as anyone over did" to statis

Zeus must have a oth spot for masourchers Alleverad, Uman save a pholograph of timesel standing down sterm, a lightmosp bot strateling down forskaj and hit on either sale. Alter hat, aspu timar, "we begen watching storms through Piecufales bubblestions on he remains an entituisaist "These are the world's most spocification so the remains and entituisaist "These are the world's most spocifications to the store of the store of the large many things that spocettiss haven" bear many things that spocettiss haven."

KITE POWER

while your hands manativer your kite. The standard model is made by Peter Lynn of New Zealand and retails for about \$850 Today, sturit buggies are rolling out the door of Lynn's factory at the rate of 15 a week.

To satisfy the water-sking kiter, a new company, Kileski, promotes a compiele setup--tok, water skik, bindings, control bar, line, bag, hat, Tehrt, Wd eo, and newsletter for S1:350—and gives instruction in the sport. Boats designed for progradision by kite are under development by Lynn and Sylvain Berthommé of France.

The sport is spreading out not only geographically but technically Veri II is still very, very new it has no teachers, no schools, no competitions, no rules not yet, anyway. Enthusiastis learn from contrades or kits shops or simply from individual experiment. And you can bet that creativity and a small dose of daring have to be part of the ationació's aucole list.

Specialized publications such as tick in assignment are greading the word about the joy of kilo power. The international quarterly recordly rain a fivepage article about kilo power, including a chronology of ket traction. Here and aboud, the sport is calching on is Statiand-op-Anon, England, for example, the first UK, Natanal Boy women, Kannon Chatterjea, had just finshed the college degree in sports with a dissertation on vice buggying.

How do people get started in krite propulsion? Motivation seems to come from a combination of factors: the contagion of friends, availability of open spaces and winds, an appreciation of

CREDITS

The second seco

the outdoors and of the therapeutic value in it.

Speed just is a large part of the artectors Sadywick selfmatten he's traveled under kills power at more than 50 millis per hour. Whatever speed you're dong, it foels the you're moving falset han you actusly are Whin 6 at admits to surpassing her flight threachol sometimes, Sadgweck laps 4 up. "I'm a wind food," he says. In spito of the trappy getusly, callock, though, Sodgweck traulay, callock, though, Sodgweck trapreserves and practices kills elidly comstanty (are: "Server Safety Rule").

If you want to start tying, you'll read three kinds of expumment a vehicle, a kite, and accessories. The vehicle can be kales, Relistribades, grass skis, a detaboard, a sted, downfill skis, war to skis, a surfacad, a bugg, or a boat. The kite can be any of toddy's ingenerating specifically for transmogio or stacked for warming for them at kmart yee, but they're available in any respectable kite store.

The man contender for the moment is the soft quad-line (four-fine) kite based on the original parafoli, an airinifiated kite that is stillened by the wind and has no frame. Soft kites have ecree obvous advantages. They cart's drog your neyhote' cars or canaums when they crash. They're also much easi tes to launch—and relaunch—without help. There to also they to the test of the standard of the standard test of the standard test of the standard test of the standard test of the by Poter Lynn (5360 to 5300), the Peel by Poter Lynn (5360 to 5300), the Peel by Poter Lynn (5360 to 53100), the Peel by Poter Lynn (5360 to 53100), the Peel Parawing by Wall Berniger 10 Gamamado in the United States (5350 to new Hempstres (All prices vary according to 5826).

Dual-infe lites work on the principle of controlling not only a kilo's vertical and hostorial movement. but its forming is done from two hardles that with only small tibing wisit movements conto the amount of power and ill of the lease. With practice, it's possible to comto the amount of power and ill of the lease with practice, it's possible to comnost movatine to be plots of herauge label and sagarate the word. Taking a label and basist again.

Framed quad-line kites also work well: For example, the Revolution (\$100 to \$300), the first popular four-liner, gives you precise control over tying Ac-



tually, almost any dual-line kilo can be regard to fly on four lines. Even with kites can give you a great ride. For years, the Flexefold (StiOC to \$400) was the favored power source, and it's stiff areas hous marked but he add it's diffusion to be taketed, or stirung together like cars in a train, to increase power in light winds.

For accessories, you'll need a variety of items. Safety equipment includes a heimet-absolutely recommendedand a windsurfar's body harness with a hook that takes the strain off your arms and lets you release the kite quickly in a dicey situation. Knee and elbow pads are also a good idea for most forms of kite propulsion. Flying fine should be 40 lengths (more or less according to the wind) of the ultrahighstrength polyethylene fiber sold under the trade name Spectra. It's stronger even than Kevlar but more prone to line cuts Choose a strength, in pounds test, that's twice your weight For about \$50, you can get line prestretched and ready to fly with handles extra (\$12 to \$20). Care and handling of lines is important and deserves patience and study

To acquire the skills, most people ast used to flying kites first, then pick up skiing, skating, or buggying skills seoond. To learn stunt flying, Sedgwick says, practice in steps and stages, proferably in winds from 10 to 15 miles per hour "The steadier the wind, the more success you'l have." Start by fiving to the right or left of the "power zone" (the center of the wind), but avoid going to the extreme edges of the "wind window' (the entire downwind area in which the late will fly). Learn to balance your body weight against the pull of the kite and to move the kite to achieve the speed and direction you want

Sedgwick and falt recommend that you wear a tape player and letter to music while you this Skeptoel? Just try ti. Many filers say music's moods and rhythms give you the feeling of dancing with your kite.

Sedgmok, always the optimist, calls kills propulsion "the sport of the Ninetes and beyond. Every time you learn something new, it leads to something else, and that leads to something else

The word on kite power is out, say Sedgwick and Taft, and the sport of kite propulsion is taking oil. At the last Valentine's Day Kee-Powerd Sis Side Tar Fix, So kitefliets showed up "It's getting bigger overy year," Taft says with a satellised beam They are both supresed the fine orghit annual Veiantre's Fix was held in 1994 CO

A Wheel CONTRA PO PROMINER IN

wonderful nictures. But that's not what I'm after I don't want to do photographs-I want to be sure to recomber fried chicken and what violins look like "After hanging up, he thought over what she'd said about this man trying to pass off other people's poetry for his own. Other people's deepest-felt emotions. It was a clever way to trick a heart but what did it say about the man? Boizer turned a few facts here and there and saw himself showing someone a famous picture he had not taken and saving, "This is one of my ten This will comfort me when I can no long-

That night he woke up and padded slowly across the dark to the toilet. Relieving himself, he realized this was what it would be like when he was old. Getting up, probably nightly, to do to the bathroom because one's plumbing beams to weaken as we arow older. A familiar sound from when he went to vis-It his parents-the toilet next to their bedroom flushing in the wee hours of the morning. The wee bours. That made him smile. A good title for a poem "Weeing in the Wee Hours." He should give

it to the poem stealer. . . . Sleepily finshing his business. Beizer once again had the feeling of some invisible connection here. Finding it would help him overcome the problem of the pictures he wanted to take

In bed again quickly slipping back into sieeo, he thought poems are as personal as fingerprints. Steal one and you instantly give your own identity, as if you were actually giving up the lines on your finders or the features on you

The features on his facel He started sat up, very much awake. An old man peeing in the night. What would be Notman Beizer, look Ike when he was seventy and bolding his old cock in his hand? He'd never know. He couldn't look at someone else's pictures of that! Too soon he'd never know how the first deep lines on his face would change him, what white hair would do to his appearance. These are important

He had begun to grow used to the idea of how much time would be wasted in his future. The seconds lost spent on useless furbiling for a wall switch or the string to pull a curtain across To move a curtain was a much larger concern for the blind. First find the strings, figure out which is the cor

rect one, bull it. A matter of seconds for a person with sight, for the blind it would take three, four, five times unfairness of that, all the time he'd soon need to waste on what he did now with no trouble. But how much of Beizer would he lose when he could no longer see hum in the mirror. Watch the progress of time and life across that most familiar geography? He sensed in time he would be able to accept the loss and forced limits that were coming, but until now he hadn't realized something so important-he would also lose large parts of himself

The next morning he called up the oflices of Voque magazine and Paramount Pictures. After running the gamut of questioning secretaries, he was finally put through to the proper people who, in both cases, were surprisingly kind and helpful. He asked the woman at the fashion magazine who she thought was the greatest portrait pholographer in the city Wrthout hesitation she said Jeremy Flynn and cave him the name of the photographer's agent. At Paramount, the vice president in charge of something said the greatest makeup person in the world was so and so Beizer carefully noted the names and addresses. He had expected more trouble finding these things out

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but perhaps since he had figured out his problem, the solution slicked into place like the gears of a cur engaging. He called the photographer and the makeup person and made appointments to see both of them. They charged an obscene amount of money, but the best were always worth it, perticularly in this case.

When he mot them, he explained his situation with almost exactly the same words he was last going bind. Balow that happened, he writed to see what he would know this for the fast of ina ac close to that all possible. The waagist should make him up to bok as conwinchigh sixtly servity, eight as possible. Knowing his family instary of bad heats dying accounties the sovention, factor assumed his word, soc. Soc mount to he in fact days to astivity.

The photographer was fascinated by the idea, He recommended pictures cane with no itcks—ro special lighting or backgrounds. Just Berzer in a dark suit and a white shirt. That way, his face would take up the entre word. The eye would be forced in lock at the face and nothing else. Yes! That was exectly what he waited

At the end of their meeting, Flynn

asked what good would the pictures be when Beizer could no longer see them, "Because I will have seen them. "I'be able to put them in front of someone and say, "is that what "I'm like now? Tell me the difference between what's on paper and what you see."

"Points of reference "

"Exactly! Points of reference."

"Will you remember what's there? Even after years of not having seen?" "I don't know I have to try."

The big day came and he had the astonishing experience of seeing himself age forty years in one alternoon. Like time-lapse photography, he saw brand-new wrinkles groove his face, making it into something foreign and funnily familiar at the same time. He saw his hair disappear, his eyes turn down, skin like bread dough hang from his chin and neck. If an experience can be funny and terrifying at the same time, this was it. Each time he was eager to see what the next decades would do to him, but when the makeup man said, "Okay have a look," Beizer was hesitant. He kept saying, "You think that's what I'll really look like?" But down deep he knew it was

So, this was it. Him for the next forty years. When he was a boy, he was a ferrible sneak when it came to Christmas presents. Every year he was driven to find where all of his gifts were hidden, so that weeks before the big day, he knew exactly what he was getting. This was the same thing. Now be knew what he would be "getting" as the years passed.

And one would think that seeing himself across the rest of this life like that would have had some kind of large effact on Beizer, but the only real emotion he felt at the end of the session was amusement. When they were finished, he told the other two this and both said the same thing-wait til you see the nictures. In real life a person wearing makeup looks ... like a person wearing makeup. Especially if It is thick and involved. But wait till Flynn's photographs were ready. Then he'd see a bell of a difference. Any great photographer knows how to cheat light and time. Flynn loved the idea of showing this man the rest of his life in pictures. He planned to use these as the nucleus of his next exhibition and thus would spend even more time than usual making them as perfect as he could.

The call came very late at night. Bezer had been watching television and eating a plum. He didn't know what he enpyed more—looking at the TV or the fat purple plum with the guts of a surnse. "Norman? This is Jeremy Flynn, Am I disturbing you?"

"Not at all. Have you finished the pictures?"

Fight's vace was slow in corriling and when it camp, it sounded like he was tasting every word before he lest it walk across his tongue. "Well yes, yes il just there's a , . . . well, i don't innow how to put it. This is a crazy question because l know it's really late, but do you think you could come over here now?"

"At eleven at night? I really want to see them, Jeremy, but can't we do it tomorrow?"

"Yes we can. Of course we can, but Norman, I think you'll want to see them now. I think you'll want to see them very much now."

"Why?"

Flynn's voice went up three notches to semihystence! The other day in fits studio he had been very calm and good natured "Norman, can you please come? I'll pay for your taxt, Just, please "

Concerned, Beizer put his plum down and nodided at the phone "Okay, Jeremy, I'll come."

Flynn was standing in the doorway of his house when Beizer arrived He looked bad He looked at the other like he'd arrived in the nick of time.

"Thank God you're here. Come in. Come in."

The moment they steeped into the house and he'd siemmed the door behighting. Frynn stanted talking, "I was golig to work on them the whole night, you glerd? I was going to give the whole other day. So I set everything up and dit he first Ion. Do you invow anything did the first Ion. Do you invow anything by the arm and was leading him quickby through the house.

"No, but I'd like to learn, I don't think I told you, but this whole thing started when---"

"It doesn't matter. Listen to this. I did the developing. I always do my own And then I—here we are, in here. Then I got down to the first prints. Do you want to sit down?"

Flynn was acting and speaking so strangely, so rushed and strangled, like he'd swallowed ar and was trying to bring it back up again.

"No, Jeremy, I'm fine."

"Okay So I put the first ones down, all ready to see you, you know, looking fifty or saty? I had all these great idees of how to work with the paper to get this special effect I've been finnking about—but when I saw what was on the tim, the firm I took of you, I panciked"

Beizer thought he was joking, but al-

so knew instinctively that he wasn't because of the scared seriousness of Flynn's voice. "What do you mean you panicked? Did I lock so ugly?"

"No, Norman, you didn't look like anything at all. You weren't in the pictures." "What do you mean?"

"Look for yoursel" "Bynn opened a very large manta envelope and slowly slid out a glossy photograph. It was of a large wheel stuck in the sand of a desert landscape.

"That's nice. What is it?"

"It's you, Norman Look at this one". Hym sidi out another photograph A hall eene, hall-comarte peture of moonlight slanting across an empty set of swings on a playground. Beizer fried to seeks but the photographer wouldn't let him. He took out another picture, then another and another. Al of them different, some strange, some beaufulu, some nothing special

When he was frished, he put has hands on hs has and looked at his subject suspiciously "That is the roll of film I took of you, Norman There was no mistake because I purposely left the film in the camera after I shot the other day. Those pictures are what the camera took of you.

"I hate to tell you, Jeremy, but i'm not a wheel, or a swing."

"I know that I didn't ask you over here to play a joke on you. That's what I have, Norman. This is no joke. Those are the pictures I look of you the other day."

"How am I supposed to respond to that?"

"I don't know" Flynn sed down. Then he stod up, "No, I do know i hawe to see something dest I have to the set of the set of the set of the set of level scare you. When I was young and learning to develop pictures. I have who I had a cush nor. Nely Cas I have who I had a cush nor. Nely Cas I have who I had a cush nor. Nely Cas Be and her mother ware Nillel 'n a cas he and her mother ware Nillel 'n a cas had nore of the spicures of her of the set her image. They came cull kee these."

"You mean swings and a wheel?"

"No, but things like that. Objects. Things that had nothing to do with her. Nen never told anyone the story, but Norman, this is exactly the same thing that happened with Kelv Exactly. I took the pictures and she died. Then I took these pictures while you're going blind. There's got to be a connection." "You think its your fault?

"No, I think I think sometimes the camera is able to catch things as they're about to happen. Or as they're to

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happening, Or" Flynn licked his lips. "I don't know. It has something to do with change. Or something to do with---"

the other's confusion. Because he realized it did have to do with change. As he looked longer at the proture in front of him and listened to the other speak. he began to understand. What had happened was Flynn's camera had photographed their souls-the dead girl's and Beizer's-as they were going through ... as they fived different things. A soul was able to try on differant existences as if they were clothes in a wardrobe. Of course a soul knows what's coming. Beizer believed the human soul knew everything; naturally with the girl, it knew her body was about to die. And in his own case, it knew what it would be like blind. So even while living in them, their souls were going out looking, traveling, window shopping for what they would become next. That was what the camera had somehow managed to capture This plain metal and plastic, chemicals and class had all worked together to catch two souls experimenting or playing, or whatever the word was for living a while in their future. Or was it their past? Maybe they'd tike to rest in the moonlight and be swung on by day. Or maybe they were only reliving what it was like to be wheels, useless and thus manyelous out in a desert.

How did he know this? How card a pish, nice, did man fike Norman Bazer realize something so sector and protond? Because as Piym spoke, Bezer began to recognize the photographus addinatory remembered being ook motallouting the moonight, or the here of allouting the moonight, or the here of all current the moonight, or the here of addinatory remembered being ook mutallouting the moonight, or the here of addinatory remembered being ook mutallouting the moonight, or the here of addinatory remembered being ook mutallouting the photographic the spoke sources that were in each of the piblices.

What was even better, he knew that that was what he would remember when he went blind. It would be enough, more than enough, for the rest of one life. He didn't need a camera, or ten unforciettable pictures, or portraits of himself as an old man. With this new understanding, he would have the ongoing knowledge and memories of where his soul had been. Until he died, blind or not, he would share the feelings and adventures of the part of him that was universal and curious The part that was traveling, experiencing, knowing hotel lives of things. Things like wheels, like swings, One more bustling soul out there looking for what to do next. DO

INTERVIEW

It was no big deal to me then. Only alter we started making measurements did I see it as a problem We got down to measuring a part in 2,000 and still weren't seeing anything. The universe looked perfectly smooth

Omni: If the universe proved to have no irregularities, then you can't use gravity to explain its structure?

Smoot: Right. And there was no other good explanation for galaxy formation. so cosmologists were in a tight spot But in 1973, we didn't even know how much trouble we were in I was just thinking about how to measure the radiation to detect the universe's rotation. One person was already trying to do this from a mountain top, and another group was attempting it from balloons, I wanted to try it with airplanes. NASA had flown U-2s for Earth resources photographing crops and the coast of California to make sure it was protected. I talked about it, and Luis Alvarez and the others in my group got excited, so we went ahead with the U-2 But all the hatches on the U-2 were bottom hatches; this was, after all, a spy plane, designed to look down. After many dealings, Lockheed finally configured an upper hatch that let us look out into space. Omni: Instead of finding rotation of the universe, you discovered the motion of the galaxy

Smoot: We found a pattern in the background radiation—a dipole—that showed the Milky Way was moving through the radiation. We colculated the speed of the galaxy at 600 kilometers per second. We look the plane to Baru to rappat the work in the Southern Hemsphere, to show the effect was not just some local anomaly. It was pretty cefer the universe was turny.

There had to be an enormous mass capable of pulling our galaxy around at such high speeds. Our galaxy is a huge, tenuous thing, and if you try to accelerate it by just grabbing hold at one end, it will come apart. You have to pull all of it together and with almost the same force or else it will stretch apart. For a cluster of galaxies, like our local group of 14, you need a much bioger mass, still farther away, to pull them together. After the U-2 results. around 1979. I realized that these huge masses must exist out there and that we had to look for them. I foured we'd find the variations in the background radiation, and find them soon Omni: Yet it was ten years before the COBE satellite was ready for hftoff. Alter the space shuttle Chailenger disaster, it had to be redesigned to ride on a rocket instead of the shuttle. How did you feel on that morning in 1989? Smoot: Some nervousness, it was the moment of truth! Alpher and Herman, two of the guys who predicted the cosmic background radiation, were at Vandenberg Air Force Base. The sun was barely starting to come up as we faced the Pacific Ocean. I could see our shadows falling forward, toward the launch pad. When the motors turned on and the rocket started to lift, our shadows were suddenly thrown behind us I remember how quickly the rocket seemed to turn and on away behind me All of a sudden, the Dela rocket's 1-in-30 failure rate seemed awfully high

As the spacecraft flow over the South Poic one hour after takeoff, the reflected sunfight produced extra power to burn. So the DMR Differential Microwave Radiameter) turned on. Then we innew that sunved the Bunch In January 1990, two months after the spectrum of the background radiation, showing that it matched the Big Bang theory's prediction procleavy.

Omni: Your own work on COBE Inferences in the radiation's temperature. Smoot: That's why the experiment took so long and was so hard. We're talking about differences of one part in 100,000-or smaller. It's like measuring the distance between New York and San Erancisco to within one foot. That may seem like a simple matter of calibrating your car's odometer and driving across the country. But you've got to take into account the fact that roads aren't straight. What happens when you pull off for cas? If it's a warm day and your tres expand? That changes measure ments-perhaps 50 feet in a mile.

We showed that space is ten times as tencogeneous as we thought. that it is uniform to one part in 100,000. No manmade things, not sven a billiard ball, is anywhere naar that smooth The universe turned out to be amoother than event. But the big news is—it's got universe turned out to be amoother than event. But the big news is—it's got the lowing at a babuly queen and toousing on the nny mole over her left eye or on her one gay hair.

Omni: How did you feel when you realized what you had found?

Smoot: We didn' see it right away. The first thing that became clear was the quadrupole pattern, which didn't areas from our motion in space—like the dipole we'd seen with the U-2-but from the cosmos itself. Instead of announcing that finding right away, i soid, "We've got to check it over" in that The Answers to Life's Questions are Closer Than You Think



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year of checking, we saw that not only was there the guadrupole, which is like the second harmonic of the dipole, but there were other irregularitiesoctupole and hexadecupole-representing the third and fourth harmonic. We tound a whole spectrum of irregularities of all different sizes. We'd uncovered a whole bunch of puzzle pieces at once. it was comparable to finding that the DNA strand was a double helix. I remember sitting here, looking at the curve [on the graph of data points), and saying, "Abal Aba!" I was pretty sure but wanted it checked. Your credibility is very important. Ed anticipated that once we made the announcement, we'd be in for three or four years of controversy.

Omni: Instead, you've found agreement and confirmation

Smoot: Well, so far. And the second year looks much like the first. So the only thing we have to worry about is, are the data in agreement from one year to the next because sconething is wrong with our software? I have a lot invested in it now. If I'm wrong, I'll have a difficult time fung it down.

Omn!: Haven't you already received confirmation from an MIT experiment with balloon equipment?

Smoot: Some. While not quite as sonstive as the COBE DMR maps that covor the whole sky, that experiment's results covering a guarter of the sky correlate well with ours. A primarily Spanish-British experiment in the Cenary Islands is also scanning strips across the sky with three telescopes specially designed to look at three frequencies so they can tine measure. And we're hoping for more follow-ups. The analogy is: Columbus discovers America, or at least shows the world there's a contipent there. Then Magellan comes over and finds that there are really several continents. Now map in more detailtrace out what Florida looks fike. Our original COBE map is on a mammoth scale. The smallest spots are objects the size of the Great Wall and the grant youd in Bootes. We'd fike to get down

Omnii. What might smaller-scale measurements reveal?

Smoot More about how structure formed in the early universe We now have the outline, and I hope will go on the individual floateaform, seeing how the individual floateaform grow first on different scales because that would give us different singerised of the early universe. Once perfluare structures are largeduc, maybe we den trace some eaamplics through jimo—see them in more than one phase so we can tokin their exclution.

Omn': How often do you put the accu-

mulating data into the model? Smoot: We make the map in places, and wo're morging the sx-months maps for the first two years. About four years from the begrinitig of the mission, COBE with have lived its expected the mission, COBE with have lived its expected, the rest would be insurance, essentially. I don't know, but after eign years of data, I would hand to be bord.

Omni: You're ready for the next thing? Smoot: Yes. We want to go back to the South Pole, where we measured the lowfrequency spectrum in 1989 and 1991. and make a series of observations of the spectrum toward the longer wavelengths. We made better maps of galactic emissions at long wavelengths then, but we need new data to calibrate those maps. To make maps with more sensitivity or at different annular scales, you want to measure galactic emissions more accurately-not only so you can understand it better, but also to subtract it away to see the extragalactic stuff. We built this huge portable radio telescope dish and want to take it to the South Pole or some cold dry place where we can scan the southern sky. It's the least well mapped

Omni: What other pursuits will you follow beyond COBE?

Smoot! Like to push the envelope, Tm hinling about gravity waves 1 think infation is the night model of the early universe, And inflation could certainly make gravity waves, so there's a welldefined relational to between don'thy pering both of them, you can test if inflation is the right concept.

Omn: How widely accepted is the inflationary model?

Singet: Probably 10 or 20 percent of peopler nearmoday den't believe in it. They propose topological defects, have transitions, or offer throgs as the seads of the structure. Conceivably, some of their theories outd at all be right. Thange to too well, and sometimes wave, soout gating to their efficient too much see that it stends in my way of how-in making to be able to step back and look at the data without too much preconsolition.

But when I save that curve back in Fedinary 1992, I acid. "Boy, Inflation is right." I den't have so mach vested intorest in inflator until that moment. I that is keep at the theory out of the paper announcing the discovery. All these theories, including could dark matter, mg/tib de dear in the water white the data should shift be right, but I could'in the furtheations titled with inflator. So I der't succeed entrolly

Ornn: Where's the line between accept-

ed theory and speculation?

Smoot. The Big Bang is standing on firm footing, inflation on much less firm footing. But it's reasonable to tell people about it, because it's a beautiful dea and stretches your mind, it's also likely to be right. Now dark matter is on more tenuous ground. Detecting it will revolutionize particle physics and tell us how to change the standard model. which now has many loose ends. Standard models exist in both particle physics and cosmology. In fact, the inflationary Big Bang is the standard model in cosmology. I suspect dark matter with be a key interlocking puzzle piece, but we won't know what that is until we

Omni: We often hear the word elegance in describing a powerful idea or theory. What does it mean to you?

Smoot: A theory can be elegant in ones of how ways. It can to drivers ideas to getter in a neat way, or it can appear just ploin boathill in its formulation. People like general relativity because its equators are equivatent to poetry in math. The written equators have beautiful lines to them, like haku. The elegance comes in the simplicity and internal remain.

Omni: Does the universe have something like free will? Or did it have to advance to this stage in this way?

Smooth R could have goine many different ways. Like a human II—do you have to end up a certain way? No, you have to end up a certain way? No, you have to end up a certain way? No, you you're born and get bager, you learn a dc, end up coping with the word, and presumably gain perspective and maproximably gain perspective and many down of the second second presumably gain perspective and that? They have a lot of choces, put the universe also have a lot of choces. Universe also have a lot of choces and universe also have a lot of choces. Developed is presentability overall orivologies is presentabili.

The logical extension of this is, "If the universe develops from a simple state, then forms all these stars, galaxies, what have you, and keeps getting more complex, how likely is it that inelificent before exist on other planets?"

Wet, it's caterney along-boards of inflation. Even if the probability is optraordinarity small, the universe probabic ontaries many more than the feat biling spheres we can see You could say where as a probability of the univverse ends just past our horizon. There's no way to prove or disprove there's no way to prove or disprove raters is probability a hundred to a mifeat mine strager than wate we can see. That's my version! CO

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GAMES

AMAZING MAZES:

And smiley faces that say much more than, "Have a nice day"

By Scot Morris



Scott Kim has created a challenges for the computer game Heavon & Earth. published by Buena Vista Software. Most of his games computer-mazes, for example, that change their configurations as you work your way through them. But one of his ideas also works. with paper and pencil; it's called an Antimaze, and a sample designed especially for Ommis shown above.

In an antimaze, the rules are reversed. You can go through walls but not through empty space. You can only move perpendicularly through a wall segment. one square at a time. In this sample, the object is to trace a path from the red. We've shown one possible starting path that leads to a dead end. The actual

solution is much longer We'll print it in a future issue

Smle

People who use E-mail and converse on computer screens have developed a host of symbols to convey the emotions behind their words usually little faces the left (or turn this page 90 degrees to the right). For example, -) is a smiling face and -(is a pout

Originally called "emoticons," these faces are now Try your hand at the smiley quizzes below

A. Match each smiley at left with its identity B Match each smiley at right with the appropriate quote Answers bekw.

2	+-(-)	1177
4.	nn-D	+(
5.	oCc;-)	-8.
8.	-lx	3.4
7.	-18	0-)
8.	-)	-Q
9.	-1	(-
٥.	(8)-)	(d:-)

- The identities (A)
- A Charlie Chaplin
- B Jacques Cousteau

- F. Carmon Miranda
- G. Dolly Parton
- L Sanator Paul Simon J Uncle Sam

The quotes (B)

- a. "Always wear safety classes."
- h "Boo boo!"
- c. "I have a black eve "
- d. "I accidentally shaved an
- evebrow off." "I'm from Australia

- I. "I'm innocent!" "I love to smoke."
- h, "I'm tongue-tied." 1 "Like my touppe?"
- "Play ball!"

Now that you've seen our favorite smilevs, send us your best original smiley on a postcard. You may enter more than once, but come the property of Omni The grand-prize winner will receive \$100, and four runners-up will each get \$25. Send entries, post marked by April 1, 1994, to Omni Competition #56 324 W. Wendover Avenue, Suite 205, Greensbord North Carolina 27408 DO

ANSWERS

(A) 1J, 2A, 3H, 4E, 5F, 6I, 7G. 8C. 9D. 10B (B) 1b, 2c, 3d, 4a, 5h, 6i, 7f, 80, 96, 10

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BAC



Bacardii, rum, Made in Puerto Rico, picke, tré su tenci nel tre sué tence ne resettes michand ar acues accurrentantes enacementes en avec a destri a de set even