Technology Review

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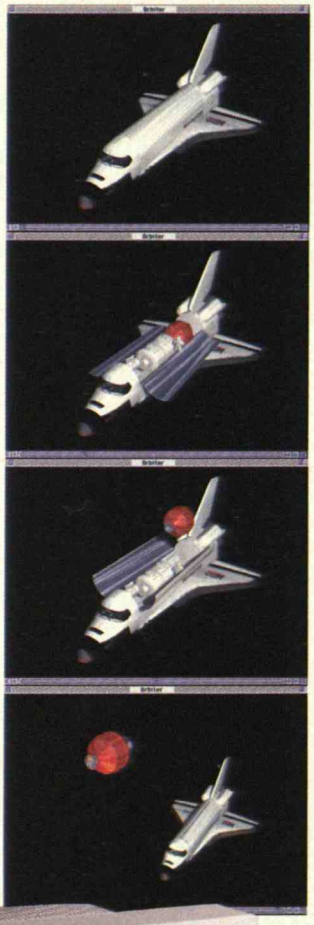

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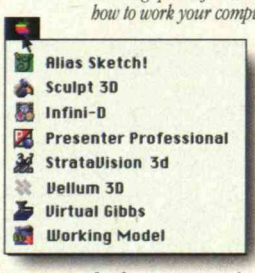

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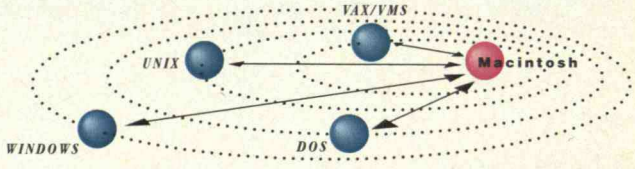

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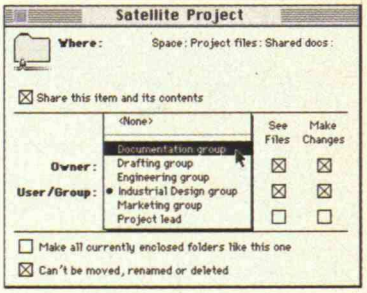

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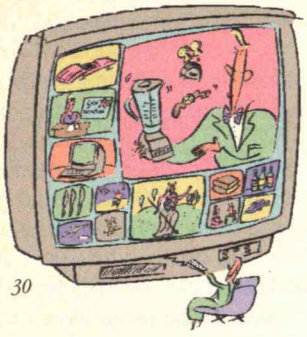

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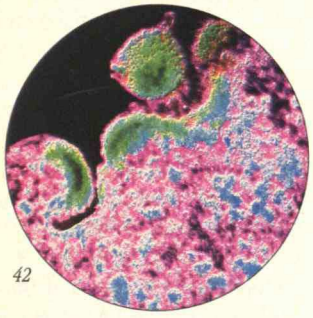

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FEATURES

Cover: This HIV particle, budding from an infected cell, is ready to invade others. Research into such viral treachery is starting to unravel the mysteries of the human immune system.

PHOTO: CUSTOM MEDICAL STOCK/SPL

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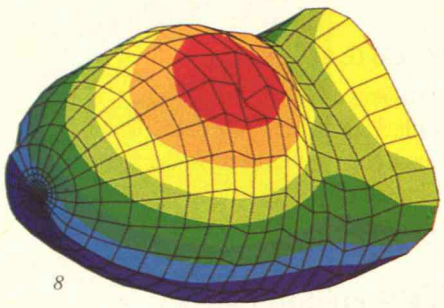
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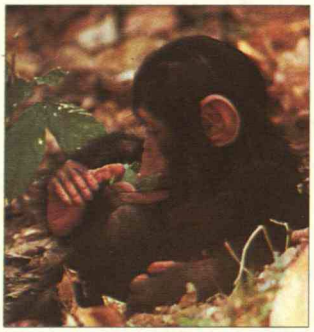
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First Line

Climbing Down From the Pedestal

WITH its heartstopping chases by dinosaurs who seem very much alive, hungry, and relentless, *Jurassic Park* is both terrifying and entertaining audiences across the country.

Some scientists are undoubtedly also feeling scared, though for different reasons, and not quite so amused, by either the film or the book, Michael Crichton's best-selling 1990 novel. Given *Jurassic Park*'s gross exaggerations of present scientific capabilities and the basic story's seemingly pervasive "anti-science" tone, researchers may understandably fear that their image could take another beating: moviegoers might look past the fantasy and artistic license to further condemn the same folks they see as having brought us *Challenger*, Chernobyl, and global warming.

Consider the following stupendous fictional breakthrough on which the plot of *Jurassic Park* depends: Working with DNA fragments derived from insects trapped in amber, biologists piece together enough of the genetic codes of dinosaurs (on whose blood the insects fed) to clone several species of the extinct colossi. These efforts, spearheaded by entrepreneur John Hammond, are not directed to some noble purpose. They are meant to make possible a theme park—Jurassic Park—that promises to be no less than "the greatest single tourist attraction in the history of the world."

The story's action takes place shortly before the scheduled grand opening, when several guests are given a tour of the premises. The park's staff of scientists, engineers, and technicians assure them that its numerous, state-of-the-art, and supposedly fail-safe features completely eliminate any danger. "We have everything under control," Hammond insists. "We've engineered the animals and engineered the resort." But the audience is soon poignantly reminded that technological systems, and the people who design and operate them, are less than perfect. Nothing can supposedly go wrong, but just about everything does.

The resulting calamity is not just a fictional, unfortunate, and isolated accident, according to Crichton. "Ever since Newton and Descartes, science has explicitly offered us the vision of total control," mathematician Ian Malcolm (Crichton's apparent voice in the story) maintains. "But in the twentieth century, that claim has been shattered beyond repair" because the would-be controllers have reached their limits. Scientists and engineers "don't have intelligence," claims Malcolm. "They have what I call 'thintelligence.' They see the immediate situation [but] they don't see the consequences."

Scientists are fair game for storytelling and public criticism because they are fallible players in a true-life, all-too-human drama.

As the plot of *Jurassic Park* makes abundantly clear, Crichton is especially concerned about the risks of biotechnology. But in case anyone misses the point, he says so directly. Not only is the biotechnology revolution ubiquitous (with research conducted in thousands of facilities, mostly private, throughout the world), often directed toward frivolous ends, and largely without the ameliorating influence of coherent government policy, he asserts. "Most disturbing is that no watchdogs are found among scientists themselves. It is remarkable that nearly every scientist in genetics research is also engaged in the commerce of biotechnology. There are no detached observers. Everybody has a stake."

The film actually deals lightly with such concepts—and most others—to emphasize special effects: the lifelike dinosaurs are indeed an awesome tour de force of high-tech puppetry and computer animation. But aside from recalling the Frankenstein myth, the film's scientific message (as opposed to the book's) doesn't amount to much. In fact, with little surviving message of any kind, *Jurassic Park* is basically a knee-jerk action movie. Worried scientists can therefore relax, unless film audiences go back and read the book—from which all of the above quotes are taken.

Crichton's depiction of science in the original *Jurassic Park* is unambiguous and harsh. But even there, his indictments should not be dismissed simply as "anti-science" any more than a movie critic's negative reviews should be regarded as anti-film. He is a storyteller (in fact trained as a physician) giving creative expression to what he sees as worrisome trends in a dramatic, potentially harmful, but correctable enterprise.

Scientists may find it difficult to accept some artistic distortion in their fictional characterizations, and even abide public criticisms of their *actual* endeavors, because they have for so long been regarded as saints—as benefactors who selflessly work miracles for the masses—rather than as competent but ordinary people who come complete with human frailties. Thus like any other influential decision makers, scientists should be willing not only to accept criticism but to respond with meaningful changes—much as they do so well within the scientific community.

Rather than fret about less-than-worshipful treatments such as that in *Jurassic Park*, the best strategy is simply to get off the pedestal. Scientists need to own up to their limits and be ever vigilant, in concert with other professionals and the public, to situations in which their formidable strengths could misfire. As almost any of the characters of Isaac Bashevis Singer, the great Yiddish writer, might say: "So? Am I not human? And does a human being not make mistakes?" ■

—STEVEN J. MARCUS

Letters

THE SHAPE OF THINGS TO COME

In "Tomorrow and Tomorrow and Tomorrow" (*TR April 1993*), Warren Wagar fails to mention the most brilliant attempt at scientific prediction ever made—the writer J.D. Bernal's 1929 essay "The World, the Flesh, and the Devil." The piece opens with this challenging statement: "There are two futures, the future of desire and the future of fate, and man's reason has never learned to separate them."

Perhaps the true measure of a civilization is the command it has over its own destiny. Our time has been called the information age, but information is not knowledge, and knowledge is not wisdom. And there is something beyond all of these that is even more important: foresight. It is a rare and often unpopular talent of which the novelist and futurist H.G. Wells remains the most successful exponent—although I have never quite forgiven him for using a gun rather than a rocket to send the first space travelers to the moon.

ARTHUR C. CLARKE
Colombo, Sri Lanka

Warren Wagar's article is the best-informed and most thoughtful introduction to futures studies that I have seen. One point worth amplifying is the growing acceptance of futurists among government leaders. This acceptance has surprised futurists who can remember back a few decades when we were viewed as idle dreamers.

In 1975, Congress established its Clearinghouse on the Future, an in-house service that keeps legislators informed about important trends and forecasts. In 1985, President Reagan invited a group of futurists to the White House for a luncheon meeting with top administration leaders, including George Bush. (The discussion focused largely on how to improve education.)

Vice President Al Gore is a committed futurist who has spoken at World Future Society meetings and has long urged the federal government to establish a future-oriented Office of Critical Trends Analysis. And President Clinton's science advisor, John H. Gibbons, was formerly director of the congressional Office of Technology Assessment, which was established with futurist support in 1972. Gibbons himself has participated in numerous futurist activities.

EDWARD CORNISH
President
World Future Society
Bethesda, Md.

I suspect that H.G. Wells and his fellow futurists have a lot in common with their colleagues who read crystal balls or tarot cards: their track record may often appear better than it really is because we tend to remember only those few predictions that come true. To my knowledge, there are still no time machines or invisible men, even though Wells envisioned both.

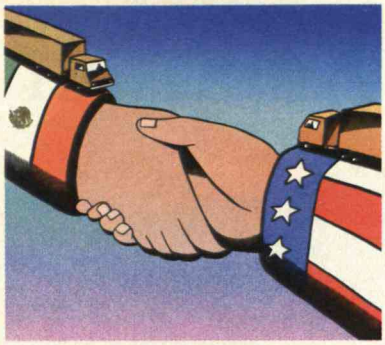
If futurists share any ideology, it is an unshakable optimism and a belief in eternal progress. Even those who predict dismal outcomes believe that there are ways to avoid them. However, given the human propensity to opt for short-term gain and ignore the possibility of long-term disaster, a pinch of pessimism might be appropriate.

ROBERT J. YAES
Lexington, Ky.

GRASSROOTS GREENING

In "The Road from Rio" (*Interview, TR April 1993*), Prime Minister Gro Harlem Brundtland of Norway rightly observes that implementing the agreements of the Earth Summit will depend heavily on the new United Nations Commission on Sustainable Development. And there is some cause for optimism. The agenda for the first full-dress ministerial meeting of the commission says that the contributions of non-governmental organizations are "indeed welcome and considered of value and importance."

That is significant because much of the



progress toward a more secure, equitable, and sustainable way of life on this planet will depend on people power. After all, it was the unprecedented level of grassroots activity that made the Rio conference the success that it was. More non-governmental organizations and citizen groups were involved in the summit and the accompanying Global Forum than in any other world conference.

The Earth Council, now being formed to complement and support the efforts of the Commission on Sustainable Development, will work with such organizations to ensure that grassroots concerns are brought to bear in decision making. From its headquarters in Costa Rica, the council is already trying to heighten awareness of the connection between the environmental and social crises in today's world. The council realizes that cooperative links developed on a people-to-people, organization-to-organization basis can provide a durable foundation for long-term economic ties and thus enhance policies aimed at sustainable development.

Of course, achieving such a goal will take time, and it will most assuredly require action on the part of governments. But there is no need to wait for governments to act. A surge of initiatives from the people themselves will ensure that the roots of sustainable development are firmly implanted at the base of our society.

MAURICE F. STRONG
Chair and Chief Executive Officer
Ontario Hydro
Toronto, Canada

BEYOND NAFTA

Clyde Prestowitz has made a real contribution to the debate over the North American Free Trade Agreement (*"Making the Free Trade Agreement Work," TR April 1993*). Harley Shaiken also has a point when he notes in "Will Manufacturing Head South?" that a loss of high-income U.S. jobs is one of the risks of NAFTA.

But there are also significant potential gains to establishing a free trade with Mexico, as Prestowitz affirms when he concludes that a favorable outcome is indeed possible if the United States negotiates some changes in NAFTA. The only problem is that the United States will probably never make many of the changes he suggests.

For example, Prestowitz says we need to be sure that the incomes of Mexicans rise so they can buy more American goods. This, he rightly points out, will require a U.S.-led program of debt reduction for Mexico. Such a program is particularly unlikely to be established. Thus we would have an agreement with a low-income country constrained by a $100 billion debt, much of which was contracted in the irresponsible borrowing and lending of the 1970s and has left citizens with a quasi-permanent burden of interest payments. Handicapped for the foreseeable future, Mexico would be forced to say, "Take our goods or take our emigrants." The influx of Mexicans into our cities could easily surpass a million a year.

Much of the discussion of NAFTA misses the point. What we need is not so much a successful free-trade agreement, whatever that may mean, as a successful Mexico. Unless we go well beyond NAFTA, we may have to share the blame with Mexican leaders for the continuing impoverishment of what will all too soon be 100 million people on our doorstep.

BRUCE R. SCOTT
Paul W. Cherington Professor
of Business Administration
Harvard University

INEXPENSIVE WAYS TO SAVE ELECTRICITY

In "The Real Cost of Saving Electricity" (*Reporter, TR February/March 1993*), P.J. Skerrett says MIT economist Paul Joskow and his graduate student Donald Marron have found higher-than-expected costs for utility-sponsored programs that help customers use electricity more efficiently.

At first glance, the Joskow and Marron figures appear to contradict or refute previous findings by the Department of Energy, the utility industry's think tank, and my own organization. But the MIT findings are neither comparable nor valid. They're simply the highly aggregated, poorly characterized, opaquely adjusted costs of savings reported for a small group of utility programs. Those, in turn, are wildly diverse, anecdotally chosen, dubiously representative, often inferior, and among the costliest in the literature. For example, the mean savings Joskow and Marron calculate for business customers cost four to six times as much as was found typical in a review of 58 utilities' programs through 1988, when efficiency cost even more than today.

The cost of utilities' programs does

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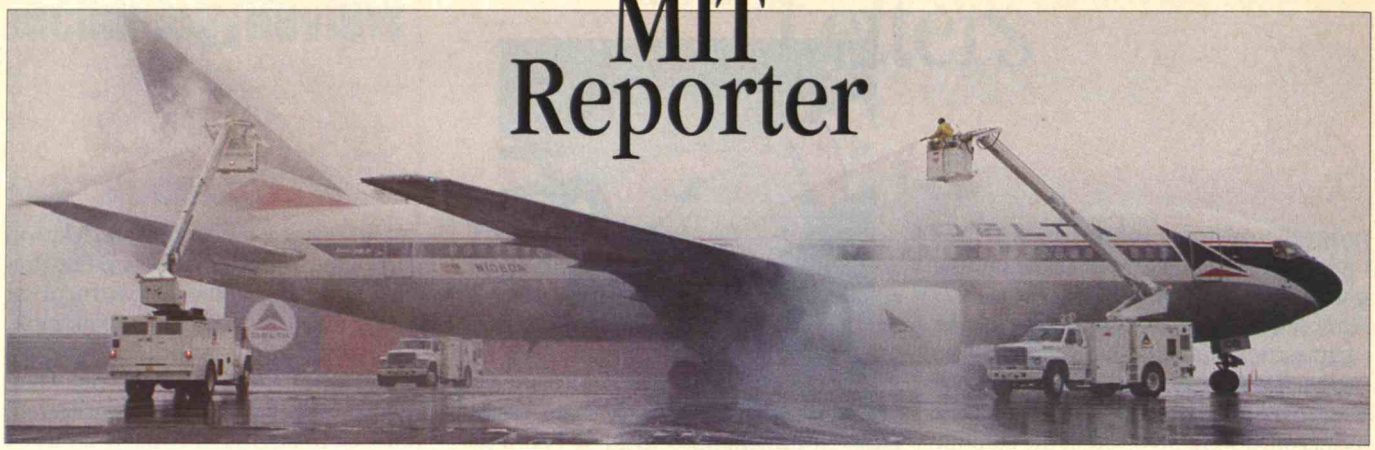

Cool Wings in Winter

To find out how long deicing fluids work after being applied, aeronautics professor R. John Hansman plans to conduct experiments on winglike surfaces. His team will examine the effects of more than 25 variables such as the rate of precipitation, wind speed, and air and wing temperature.

On March 22, 1992, a U.S. Air jet trying to take off in a snowstorm from New York's La Guardia airport plunged into frigid waters, killing 27 people. The accident was the latest in a series caused by icy wings, and it prompted the Federal Aviation Administration (FAA) to more strictly interpret rules that prohibit jets from taking off with ice or snow anywhere on their wings.

But aeronautics researchers say that the regulations gloss over a significant problem: pilots have no practical way to confirm that their planes remain free of ice before takeoff. One expert, who wishes to remain anonymous for fear of losing FAA contract work, says he is so worried that he and his family have stopped flying in winter.

If pilots were certain that the deicing fluid hosed on their planes was still effective at takeoff time, their dilemma would be solved. But, explains MIT aeronautics professor R. John Hansman, no one knows exactly how long the two commonly used deicing fluids do their job once applied. Controlled studies have not verified the approximate "holdover times" published by the FAA, admits Charles Masters, who oversees deicing research for the agency. Instead, those figures are based on expert opinions.

Such information is critical because at most airports jets are deiced near departure gates. Planes must then taxi to the runway, a maneuver that can take 10 minutes even in good weather. Although several large airports avoid this hazard by placing deicing equipment near the runway, most don't have room. Airport managers are also concerned about toxic deicing chemicals running off the taxiways' edges into soil, and about potential liability in the event of accidents.

To determine holdover times, Hansman and his students have built an indoor apparatus that sprays precise mixtures of snow, sleet, and rain on winglike surfaces. Previous experiments conducted outside were hampered by rapidly fluctuating weather. The controlled indoor environment should help the scientists determine which of more than 25 atmospheric and other variables, such as wind speed and wing temperature, are most relevant to holdover times.

With data just beginning to trickle in, the MIT engineers have found huge variations in holdover times, depending mainly on air temperature and the amount and rate of precipitation. The numbers range from hours for a cold fog to less than 10 minutes for heavy rain, which washes off the fluid. (Even when air temperature is above freezing, ice can form on wing surfaces if the wing is chilled enough, perhaps from a previous flight.) Holdover times for snow vary between these extremes.

Hansman's shorter-term goals include determining what surfaces on a plane are most vulnerable to icing. "If we can solve this puzzle," says Hansman, "then airlines could tell their ground crews where to look for ice" and spray the most fluid.

To answer such questions, this autumn the scientists plan to use a camera to observe precipitation falling on sections of a slanted flat plate or a cylinder (surfaces that are easy to describe mathematically), both coated with deicing fluid. They will also measure the thickness of the deicing fluid layer in various locations to see how fast it washes off. Then, after developing mathematical models that depict these idealized situations, they plan to repeat the simulations on a surface shaped like a real wing and tune their models accordingly.

Ice-Detecting Sensors

This research may help engineers decide where to install sensors that could detect ice. Many companies have already designed prototypes of such devices, several of which the FAA plans to test over the next several years. One sensor, for instance, consists of a small membrane that is mounted on a wing and induced to vibrate. The membrane oscillates at one frequency when covered with water and another when coated with ice. If the membrane shifts frequencies, then a computer detects the change and relays the information to a cockpit readout. Since most of the prototypical sensors spot ice only on a tiny section of a wing, information on where to place the devices becomes critical, Hansman explains.

Hansman has proposed an ice sensor that avoids the placement issue. On a plane's fuselage, he suggests, engineers could mount cameras that transmit pictures of both wings to cockpit monitors. Then, during winter storms, technicians could spray the wings with deicing fluid mixed with a fluorescent dye such as fluorescein disodium salt that glows only when liquid. A uniform fluorescent glow when the mixture is illuminated with ultraviolet light would mean it was safe

PHOTO: DELTA AIR LINES