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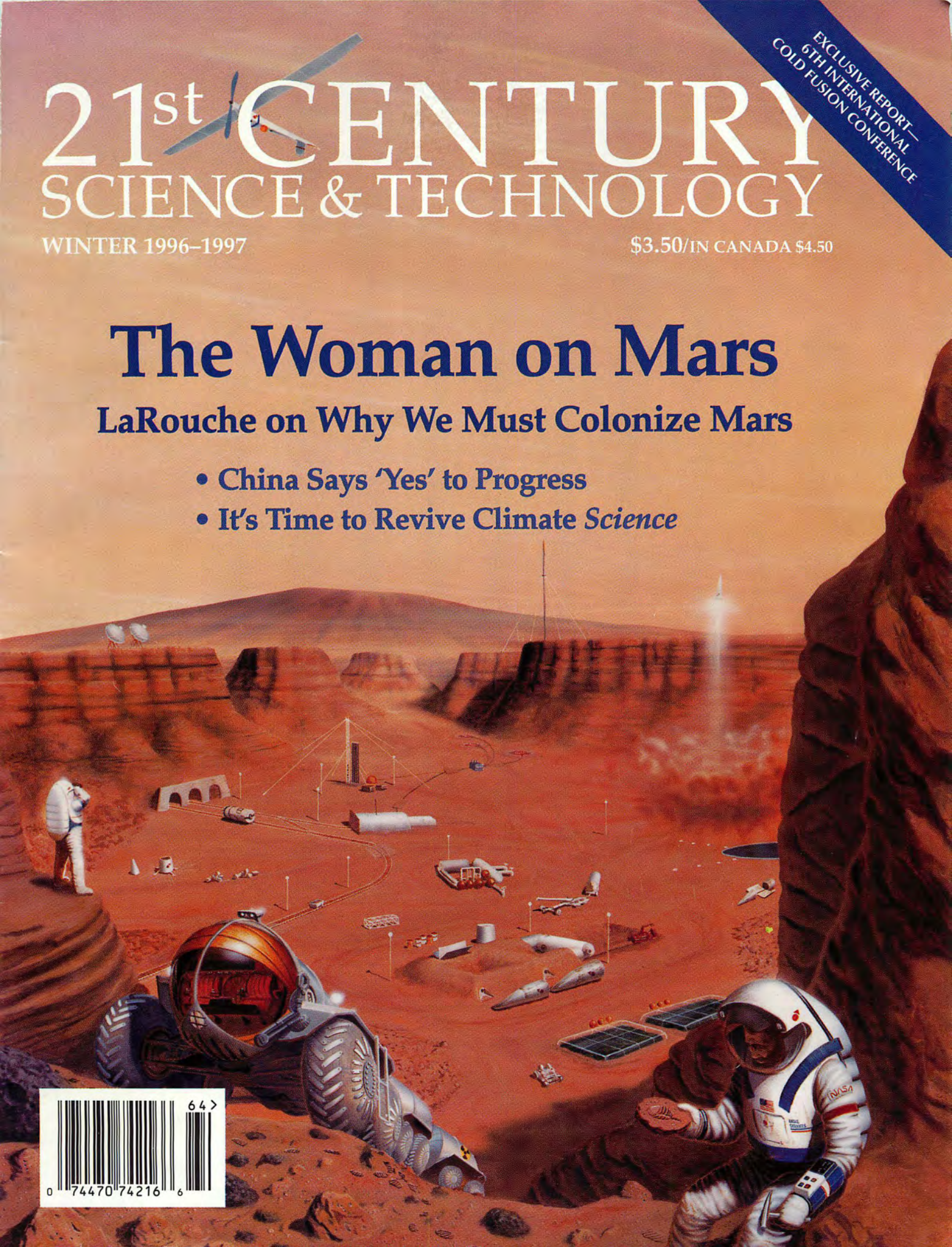
The Woman on Mars

LaRouche on Why We Must Colonize Mars

- China Says 'Yes' to Progress
- It's Time to Revive Climate *Science*



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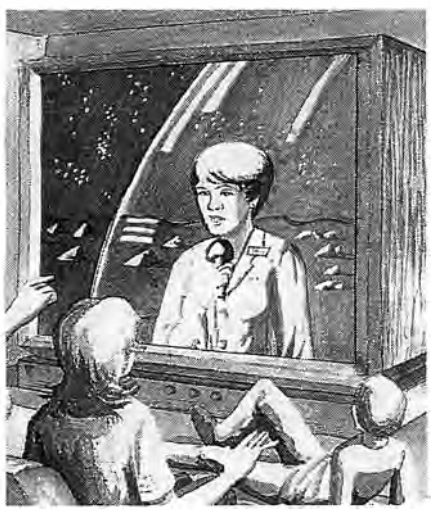
Features



"The Woman on Mars" (p. 30), the chief executive of the U.S. science-city on Mars in 2027, was a familiar face to Americans, who followed her televised reports of scientific breakthroughs the way today's sports fans follow football.

News

Departments

On the cover: An astronaut explorer on Mars (lower right) examines a fossil in this 1985 NASA illustration by Pat Rawlings. A Mars base camp is in the background. Cover design by Rosemary Moak.

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Changing the Course of Nuclear History

The wealth of new research on the beneficial effects of low-level radiation, presented at a series of technical sessions during the November meeting of the American Nuclear Society in Washington, D.C., is an immediate challenge to the U.S. medical, biological, nuclear, and regulatory communities: It is urgent that the United States begin a wide-scale research program, particularly the use of low-level radiation in regard to the treatment of cancer. It is equally urgent that we change the radiation standards that are hindering, not helping, the health of the American public.

The Japanese research with human cancer patients, presented at the meeting, indicates that a total-body dose of low-level radiation, administered with the standard radiation treatment for non-Hodgkin's lymphoma, for example, increases survival rates in human beings. Of the patients who received the total body irradiation along with the high-dose local irradiation, 90 percent were alive after six years. Of the patients who received only the local high-dose radiation, only 36 percent were alive after six years.

The initial patient samples are small, but the results are dramatic enough to warrant a crash research effort for this and for the other cancer treatments that the Japanese have begun to explore.

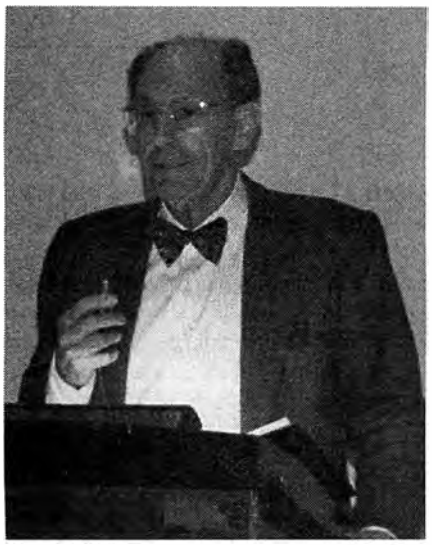
Other Japanese research presented at the meeting posed fascinating questions about cell functioning and the efficacy of present models for DNA repair. Low-level radiation seems to protect against cancer formation. How? Small changes in the low-level doses produce their protective effects on different timetables. What is going on? A conditioning dose of low-level radiation with mice increased their survival rate and increased their immune response. How does this work with human beings? Experiments with rabbits and insulin showed that a monthly dose of low-level irradiation regulated diabetes. What are the implications for human diabetics?

In the United States, most of the data on low-level radiation and health comes from looking at the low-end data of studies of higher-dose radiation effects. The focus has remained on the damage caused by high dose radiation, without regard for beneficial effects at lower doses.

Japan now has 14 universities involved in 16 areas of radiation hormesis, coordinated by CRIEPI, the Central Research Institute of the Electric Power Industry. Some of the nation's top researchers are looking into five major areas of low-level radiation effects: enhancement of the immune system (such as the suppression of cancer), the activation of DNA repair and apoptosis, the rejuvenation of cells and cell membrane permeability, the increase of key enzymes, and therapy for diseases such as diabetes and hypertension.

A Nuclear Revolution

The November 11 session on biological research that confirms the beneficial effects of low-level radiation was "the most important session" at the November meeting of American Nuclear Society in Washington, D.C., according to Myron Pollycove, M.D., professor emer-



Marjorie Mazel Hecht

Myron Pollycove: Had we known 30 years ago what we know now about the beneficial effects of low-level radiation, it would have changed the course of nuclear history.

itus in nuclear medicine at the University of California at San Francisco.

Pollycove, who introduced the several speakers at the session, stated dramatically that had the beneficial health effects of radiation been known 30 years ago, it would have changed the course of nuclear history. Had we known back in 1960, what we know now about the the effects of low-level radiation on the human body, he said, the benefits of radiation would be widely available today and people would think differently about nuclear energy.

Unfortunately, Pollycove said, this information on hormesis is coming at a time when nuclear energy, long under siege, needs a "last ditch defense." The entire future of nuclear technology, he said, depends on the realization of the actual beneficial health effects of radiation.

How to change this situation was the subject of much discussion at the ANS meeting. Many scientists believe that if their information is "bullet-proof and impregnable," to quote Pollycove, they will convince a frightened public of what's right. But this is not enough. For three decades, the *irrationality* of the anti-nuclear environmentalists has been battering away not just at the nuclear industry, but at the foundation of industrial society. What's needed is a top-down policy decision for a full nuclear research program to accompany the 40-year Moon-Mars mission described in this issue's feature articles—biological and medical research, advanced power reactors, space propulsion, and fusion.

Given the health possibilities alone, nearly 55 years after the first U.S. nuclear reactor, we are really just beginning the nuclear era.

Radiation, Science, & Health

An international group of scientists has recently formed a non-profit educational organization—Radiation, Science, & Health or RSH—specifically to document and make widely known the scientific data on low-level radiation health effects. Describing themselves as "independent individuals knowledgeable in radiation science and public policy, committed to change radiation science policy in the public interest," RSH has a distinguished founding board, including Nobel Laureate Rosalyn Yalow as honorary director.

One of RSH's immediate targets is to press for a change in the current "linear no-threshold" approach to radiation protection, which holds that all radiation is harmful, that there is no threshold below which its effects are harmless, and that the harm can be calculated as a linear extrapolation from the known effects of damage from high dose radiation (that is, from Hiroshima and Nagasaki atomic bomb survivors).

As RSH states, the results of this policy are wasting upwards of $2 trillion worldwide, at the same time that such a policy causes public fear and actually produces adverse public health effects. In other words, RSH asks, "Has radiation protection become a health hazard?"

Readers interested in contacting RSH can write Radiation, Science, & Health, Inc. at Box 843, Needham, Mass. 02194. RSH president James Muckerheide can be reached via e-mail at jmuckerheide@delphi.com

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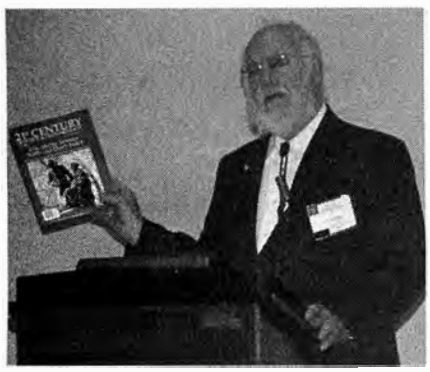


Marjorie Mazel Hecht

Dr. T.D. Luckey shows the ANS audience a copy of the Fall 1996 issue of 21st Century *magazine, which features his article on "The Evidence for Radiation Hormesis."*

LOW-LEVEL RADIATION BENEFITS FEATURED AT ANS WASHINGTON MEETING

It is unconscionable not to put health physics to work on the problem of "radiation deficiency," Dr. T.D. Luckey told a special session of the American Nuclear Society international meeting in Washington, D.C., Nov. 11. Luckey keynoted the first session of a series on "Low-level Radiation Health Effects," which featured the work of Japanese researchers on the beneficial effects of low-level radiation. Other sessions covered the inapplicability of the linear, no-threshold hypothesis for low dose radiation, the data from radon and radium studies, and the need for new radiation standards that take into account the hormesis effect.

EXPOSURE TO RADON CAN BE BENEFICIAL, STUDIES SHOW

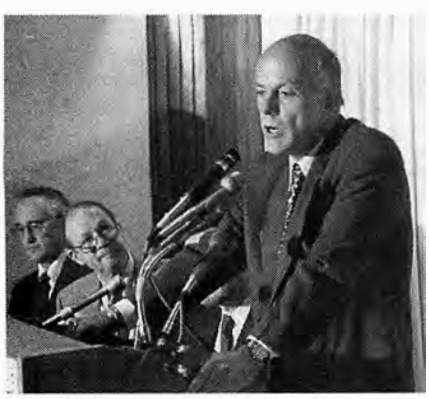
Up to a certain limit, radon exposure helps to reduce the risk of cancer by the activation of cell repair mechanisms, said Dr. Bernard Cohen, a nuclear scientist at the University of Pittsburgh. Thus, he said, the linear extrapolation of damaging effects at very high radon levels down to low levels is invalid. Cohen addressed a Nov. 12 session of the ANS Washington meeting on the topic of radon. His and other studies of the relationship of radon gas exposure to lung cancer show that people living in areas with higher natural radon levels have lower lung cancer rates. States with the highest natural radon levels—Colorado, North Dakota, and Iowa—have much lower lung cancer rates than those with the lowest levels—California, Delaware, and Louisiana.

Cohen reported on a Finnish study that showed lung cancer rates were below average in areas with 8 pico-Curies per liter (pC/l) of radon in homes. Although many areas, such as Spokane, Washington, have levels of 8 pC/l without correspondingly higher lung cancer rates, the U.S. Environmental Protection Agency claims that levels at or above 4 pC/l are dangerous,

FAILURE OF RUSSIA'S MARS '96 MISSION A SERIOUS LOSS FOR SCIENCE

The successful launch of the U.S. Mars Global Surveyor Nov. 7 was followed two weeks later by the loss of the Russian Mars '96 spacecraft. The fourth stage of the Proton booster fired improperly, leaving the craft in an unstable orbit, from which it descended into the Pacific Ocean the next day.

Following the failure, the Russian Space Agency announced that such projects will no longer be attempted, and that Russia will participate in international programs instead. The international Mars science working group is discussing follow-on unmanned missions for the 2001 launch opportunity, and a joint U.S.-Russian mission is being considered. A bipartisan White House space summit in January will discuss the future of the U.S. space program, spurred by the Mars meteorite discovery.



Stuart Lewis

Today we take for granted the "harvest" of basic research—computers, lasers, semiconductors—which evolved from discoveries made generations ago. Here, from right: Richard Smalley, Robert Richardson, and David Lee.

NOBELISTS SAY CUTS TO BASIC SCIENCE IN U.S. ARE DANGEROUS

Five recent U.S. winners of Nobel Prizes in physics and chemistry, speaking at an Oct. 17 news conference at the National Press Club in Washington, predicted dangerous consequences from cuts in the funding of basic U.S. science. The scientists were Robert Curl and Richard Smalley, Rice University, chemistry; Douglas Osherhoff, Stanford University, physics; and Robert Richardson and David Lee, Cornell University, physics. If funding cuts in R&D continue, they stressed, in 10 to 20 years we will not have the new technologies needed to provide for the 12 billion people who will then be alive.

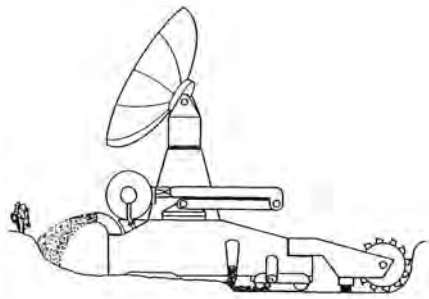
Although basic research is just a small fraction of the budget, Robert Curl stated, it is like the planting of a crop: the harvest is worth much more than the investment.

FORMER APOLLO ASTRONAUT PRESENTS MARS EXPLORATION SCENARIO

Dr. Harrison Schmitt, the only scientist to explore the Moon during the Apollo program, presented an exciting programmatic vision for Mars exploration at a Space

Summit Forum sponsored by the National Space Society in Washington, D.C., Nov. 13. Schmitt's Interlune/InterMars Initiative, is based on the idea of going back to the Moon, and then using that base of experience and technology testing to go to Mars. Schmitt served one term as a U.S. Senator.

Central to Schmitt's proposal is the idea that the rare isotope, helium-3, will be mined on the Moon and used to fuel fusion power plants on the Earth and in space, an idea first proposed by the fusion scientists at the University of Wisconsin (see *21st Century,* Summer 1990). He predicted that just 15 years after the start of such a project, helium-3 fueled fusion power plants could be operating from lunar resources.



NASA Lunar Helium-3 Fusion Power Workshop, April 1988

Schematic of a Lunar Mark-II robotic miner designed by the University of Wisconsin team that has pioneered research on mining helium-3 on the Moon.

ADVANCED FUELS WILL PROMOTE FUSION SPACE PROPULSION

New experiments using the advanced fusion fuel combination of deuterium and helium-3, will bring the reality of fusion propulsion closer, reports Dr. Gerald Kulcinski, director of the University of Wisconsin's Fusion Technology Program. Kulcinski's group has been experimenting with an electrostatic fusion device that does not rely on an outside source to heat the plasma fuel. The main advantage of using D-helium-3 is that the fusion product is largely charged particles, which can be easily captured and organized, rather than neutrons, which are the product of what are considered "first generation" fusion fuels.

Because of the 30 percent cutback in DOE funding for fusion research, Kulcinski's group is planning to raise enough money to continue the research. They first plan to produce a prototype device the size of a basketball, using "conventional" fusion fuels (deuterium and tritium), that can produce neutrons for detection devices that could be used to search for bombs and explosives. Then, with the D-helium-3 fuel, they will have a portable source for the production of protons, which can also be marketed commercially.

OZONE HOLE HOAX WILL KILL MILLIONS, MADURO TELLS ASHRAE MEETING

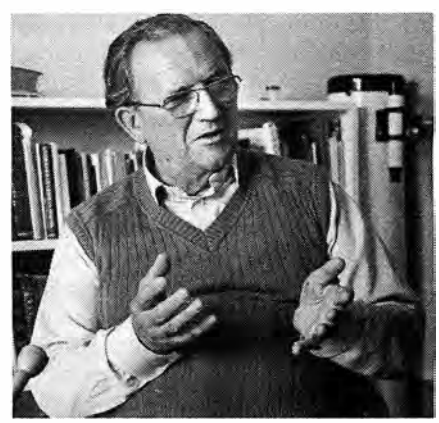
The scientific fraud of the ozone scare and its role in promoting depopulation was the topic of a lively meeting of the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) in White Plains, N.Y., Nov. 13, which featured *21st Century* Associate Editor Rogelio Maduro. This Bi-State Chapter of ASHRAE encompasses six counties in New York and Connecticut. Maduro emphasized that the ban on CFCs will kill millions, and that those promoting the ban were guilty of crimes against humanity.

ADDITIONAL PARTNERS FOR LARGE BINOCULAR TELESCOPE PROJECT

Ohio State University is negotiating to rejoin the Large Binocular Telescope project on Mount Graham in Arizona, and a German consortium has also begun negotiations. Ohio State, which withdrew from the project in 1991—when environmentalist hostilities had the project at a standstill—plans to buy a one-eighth share for $6.4 million. The existing partners have funding for only one of the binocular mirrors, but with Ohio State and the German consortium, both mirrors could be built. Completion is currently expected in about 2001.

PHYSICIST ERICH BAGGE, PIONEER OF NUCLEAR POWER, DEAD AT 85

Professor Erich Bagge of the University of Kiel, Germany, died June 5, 1996, in Kiel, at 85. Bagge was the father of the *Otto Hahn,* the first nuclear-powered ship for commercial navigation, launched on June 13, 1964. The *Otto Hahn* was decommissioned in 1979, a casualty in the drive against nuclear power. In recent years, Bagge, a student of Werner Heisenberg, had returned to theoretical physics and work on the neutrino. Bagge was an active supporter of the Fusion Energy Foundation in Germany.



Stuart Lewis

Erich Bagge during a 1985 interview with Fusion *magazine.*

Letters

Ampère-Gauss-Weber vs. Maxwell: A Philosophical Battle

To the Editor:

Congratulations on a very informative and scholarly review of the Ampère-Gauss-Weber force-law work of the last century ["The Significance of the 1845 Gauss-Weber Correspondence," by Laurence Hecht, Fall 1996, p. 21]. The electromagnetic force law issue is still alive in the hearts and minds of those of us who have not bought the special relativity package and who retain some respect for empiricism.

I missed only reference to the modern torch-bearers who carry on the action-at-a-distance tradition, by clinging to Newton's Third Law: Notably, A.K.T. Assis, a Brazilian physicist whose recent work, *Weber's Electrodynamics,* is must-reading for anyone curious about the modern status of the old ideas. Also, of course, the works of Peter and Neal Graneau, such as *Newton vs. Einstein, Ampère-Neumann Electrodynamics of Metals* (Peter Graneau, Hadronic Press), and *Newtonian Electrodynamics.*

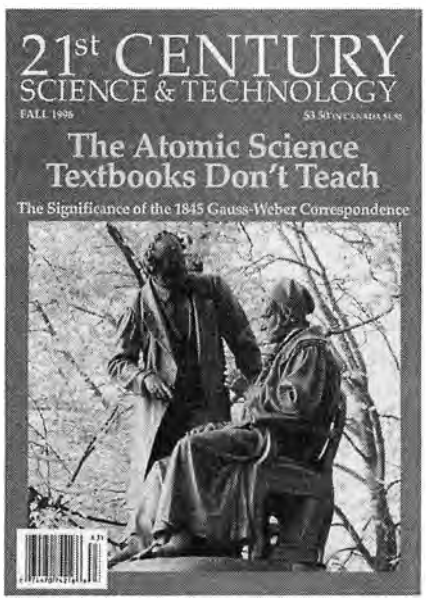
Howard Hayden's journal, *Galilean Electrodynamics,* started by Petr Beckmann a few years ago, is a rich source of dissident thinking in the older tradition. A small Canadian journal, *Apeiron,* edited by C. Roy Keys, is a similar source, more on the side of cosmology.

Maxwell, perhaps as a strategy of conquest, but quite correctly, spoke for the importance of maintaining plural lines of inquiry in basic physics. That sentiment is much more important for our own day, in which field theory seems to have crushed all opposition. So it is useful to identify some of the main workers for pluralism of descriptive assumptions in our time.

Thomas E. Phipps, Jr.
Urbana, Ill.

The Author Replies

Maxwell's positing of the distinction between the Gauss-Weber tradition in electrodynamics and his own views, as that between *action at a distance* versus *field conceptions* was either ignorance or willful fraud. One suspects some of both. We must refuse to constrain our thinking to either one of these sterile channels—no matter how much generally accepted classroom mathematics demands we do so. There is no freedom of thought—and, I write this answer from a Virginia penitentiary as a political prisoner of George Bush and his Justice Department under former Assistant Attorney General William Weld—so long as we allow our opponents to define the choices of approved response.



Ampère, Gauss, Weber, and Riemann were not Newtonians! They were, each of them, solidly grounded in the anti-empiricist (not anti-experimental), anti-Newtonian tradition of Kepler and Leibniz. It's time to be done with Maxwell's ignorant account of the matter, once and for all.

Thus, one may reject what you call "the special relativity package," without reopening the Pandora's box of errors and assumptions of Newton's system. For example, the *paradox of simultaneity* was with us from the moment Ole Roemer had demonstrated the retarded rate of propagation of light from Jupiter's moons. The issue addressed in relativity theory was already rigorously posed in 1696 in Jean Bernouilli's famous work on the cycloid, where it is demonstrated that the cycloid is the curve of least time, both for a falling body, and for the propagation of light in a gravitationally contained medium.

Einstein's special relativity formulations were a necessary correction to save the Maxwellian system. In the Gauss-Weber-Riemann electrodynamics, as we know, the same problem had already been addressed, almost a half-century before Einstein, through the concept of a retarded rate of propagation of potential. The more fundamental ontological assumption, not properly addressed in any modern mathematical-physics treatment, is raised by Gauss and Riemann's investigation of curvature. Scientists will avoid the implications of Riemann's 1854 *Hypotheses* paper only at great risk to the future of their discipline.

My friend Peter Graneau, René Saumont in France, and others, have done useful and provocative experiments, demonstrating again, and in new ways, what Weber had already determined by 1845—that is, the existence of the Ampère force. But, we must remember, this is fundamentally a methodological, a philosophical battle, which is not going to be resolved by any experiment, no matter how ingenious or convincing. It touches on the issue of experimental design, only from the deeper standpoint of underlying hypothesis.

While I don't discourage the reading of the works you mention, I insist that the *must* reading list consist of the original sources, which I cited in my bibliography, although to be comprehended, it must be preceded by a careful study of crucial works from Cusa, to Kepler, to the school of Leibniz.

To recognize the enormity of the fraud presented in today's textbooks on science and the history of science—that is, the fraud behind one's own education—it is necessary to follow firsthand, to re-create in one's own mind, the hypotheses and paradoxes confronted by these inventors of modern physical science. One cannot, as modern science teaching methods dictate, throw away the hypotheses, as if they were the no-longer-needed scaffolding of a building project, once the edifice of algebraic formalism has been constructed. He who does so, will remain forever a prisoner of his own, unrecognized, naive assumptions.

IMPRESSIONS FROM A VISIT

China Says 'Yes!' to Progress

by Jonathan Tennenbaum

EDITOR'S NOTE

Jonathan Tennenbaum heads the Fusion Energy Foundation in Europe and is the editor of the German-language magazine Fusion. *He works closely with the Schiller Institute, which has put forward detailed development programs based on large-scale infrastructure projects.*

While we in the West seem to take a perverse joy in dismantling and destroying our once-prosperous industrial economies, the Chinese government has opted to rapidly industrialize its country on the basis of the most modern technologies. In spite of its enormous problems, the atmosphere in China today is full of optimism—a most refreshing contrast to the self-destructive culture of pessimism and rage, which has come to dominate much of Western society, especially over the last 30 years.

The occasion of my visit to China was an invitation from China's State Committee for Science and Technology to participate—together with my colleague Mary Burdman and Helga Zepp-LaRouche, Schiller Institute founder—in a major international symposium in Beijing in May 1996. Following that symposium we took part in a series of seminars, discussions, and visits to various institutes. This included the Qinghua University research center for nuclear energy, where China's first High Temperature Reactor (HTR), based on the German "pebble bed" design, is now under construction. Besides the HTR project, which is to be completed by 1998, the Qinghua University group has been successfully operating a prototype for a new form of low-temperature heating reactor, to be used for urban heating and desalination applications. We also took an interesting trip to a farming region in Hebei Province.

Lanzhou Railroad Bureau

China is improving the connections of the continental bridge with tunnel structures like this one on the Baozhong Line.

The subject of the international symposium, "Development of the Regions along the new Euro-Asian Land Bridge," was of particular interest to us. The term "Land Bridge," or "Continental Bridge," refers to the 10,000-kilometer-long transcontinental railroad line, which runs all the way from China's Eastern harbor city of Lianyungang, through the Northwest of China into Kazakhstan, and from there northwest to Russia, passing via Moscow, Minsk, Warsaw, and Berlin to the famous "Europort" at Rotterdam.

Although major sections of the line have existed for many years, the final

missing gap, between China's Xinjiang (Sinkiang) Province and Kazakhstan, was completed in 1990, and it opened for container railroad traffic in 1992.

Taking part in the symposium were more than 460 representatives from 36 nations, including leading diplomats and statesmen, as well as experts in transport, energy, and communications technology.

Major Diplomatic Initiative

The symposium was held as part of a major diplomatic initiative of the Chinese government, to transform the Eurasian Land Bridge into an axis of economic development for the entire Eurasian land mass. Europe and Asia together contain three-fourths of the world's population, or about 4.5 billion people. Besides the benefits of trade and cooperation with the other nations of Asia and Europe, China wants to use the Eurasian Land Bridge as a means to overcome the economic discrepancy between its own rapidly developing provinces on the coast, and the poorer, more backward areas in the interior of the country.

The speeches by Chinese officials at the symposium made it clear, that the Eurasian Land Bridge is no mere public relations stunt. China has already made major investments in developing the physical infrastructure along the transcontinental rail line, and preparing the economic structure of the adjacent provinces for what the Chinese call the "New Era of the Continental Bridge."

During the past 10 years, more than 2,000 kilometers of the northwest rail line in China have been double-tracked, large sections electrified, and numerous branches and parallel lines constructed. The ports at Lainyungang, Rizhao, and Qingdao are being expanded and modernized, and transshipment facilities have been built up at nodal points along the rail lines. Besides improvements in the transport network, scores of new industrial projects are being launched, with a view toward utilizing the rich mineral resources in the northwestern regions of China along the Land Bridge.

Another, very significant international project connected with the Land Bridge, is the construction the Trans-Asia-Europe Optical Fiber Cable, running from Shanghai in China to Frankfurt, Germany, with a number of branches along the way. Scheduled to be completed in 1997, this will be the longest, single overland communications cable in the world, providing high-capacity data links based on state-of-the-art technology for China, Pakistan, the Central Asian countries, Iran, the Caucasus, Turkey, Ukraine, Belarus, Poland, Hungary, and Western Europe.

Schiller Institute

The opening session of the international symposium in Beijing.

The invitation to Mrs. Zepp-LaRouche and myself to speak at the Beijing symposium should come as no surprise to those readers familiar with the campaigns of Mrs. LaRouche's husband, the economist and political figure Lyndon H. LaRouche, Jr., for a policy of global development based on large-scale infrastructure projects and advanced technologies.

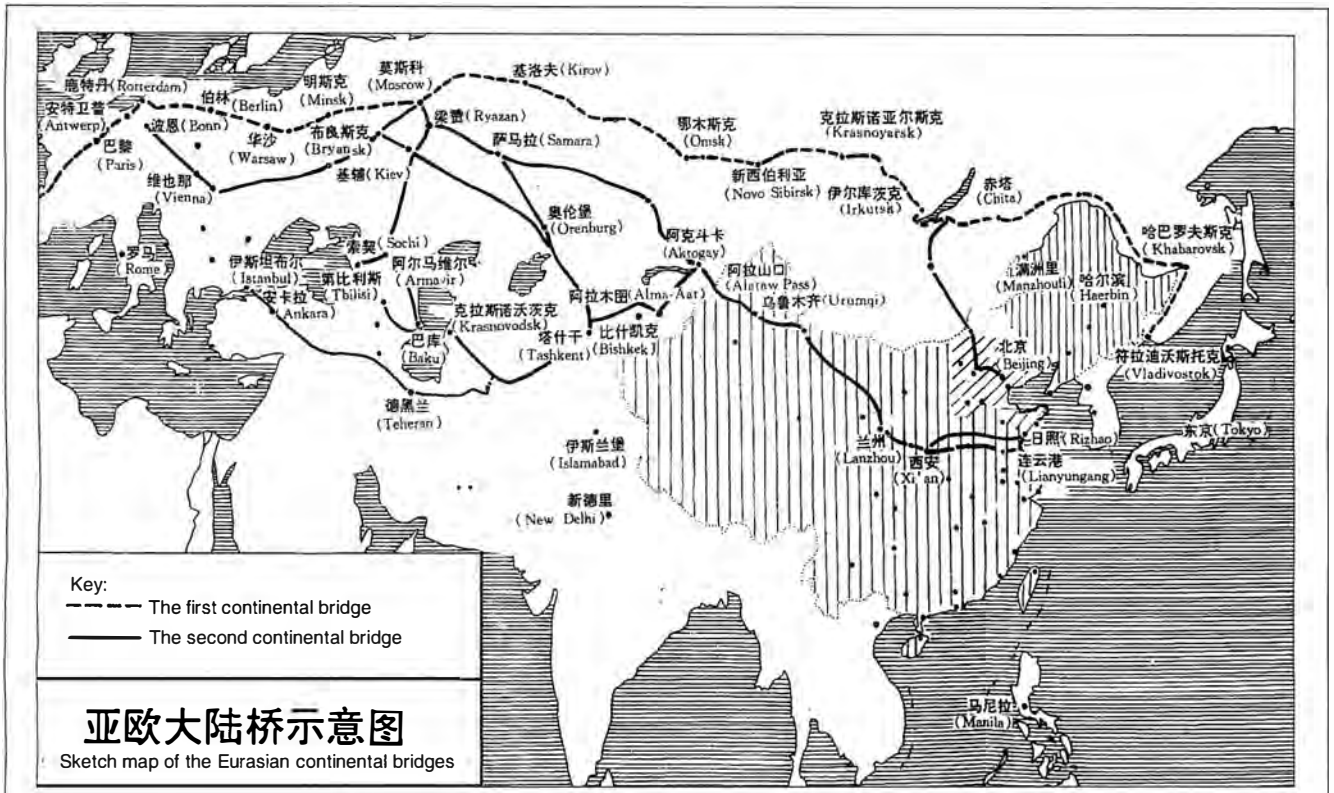
The Productive Triangle

Back in 1989-1990, LaRouche and his collaborators circulated a detailed plan for rebuilding the economies of Eastern Europe, which became known throughout the world as the Productive Triangle, Paris-Berlin-Vienna. The centerpiece of the program was to combine high-speed rail and maglev transport systems together with nuclear energy production and energy distribution systems, water systems, and communication networks, to create an array of high-density infrastructural corridors as the backbone of a rapidly expanding economy.

According to LaRouche's policy, such large-scale infrastructure development would be financed by the methods of productive credit generation by national banking systems, following principles pioneered 200 years ago by the first Treasury Secretary of the United States, Alexander Hamilton. Thus, the Productive Triangle policy was coupled with an urgent reform of the world financial system, which, of course, is today more urgent than ever. Lyndon LaRouche's analysis of the breakdown crisis of the present world financial system has been discussed in numerous articles in the Chinese press, which often refer to the breakdown process as "financial AIDS."

The originally proposed corridors of the Triangle included lines running eastward and southeastward through Russia, Ukraine, and the Balkans toward the Near East and Asia. In 1992, LaRouche's program was extended into a blueprint for a combined Euro-Asian infrastructure network, which attracted a great deal of attention in the relevant countries, including China. Not surprisingly, one of the Chinese speakers referred explicitly to the Productive Triangle Paris-Berlin-Vienna as the Western pole of the Eurasian Land Bridge—the Eastern pole being China itself.

LaRouche's concept of infrastructure development corridors, elaborated in the accompanying article, agrees closely with the thinking of some leading economic policy-makers in China and some other Asian nations. For a number of years now, people in China, Central Asia, Iran, and other Asian countries have been talking about a renaissance of



THE MAIN CONNECTIONS OF THE EURASIAN CONTINENTAL BRIDGE

Source: Reproduced with kind permission from Gao Zengang, ed., *A Study of the Strategic Meaning of the New Eurasian Continental Bridge*, Jinan, 1996

the famous Silk Road—the system of land and sea trade routes, which linked Europe, Asia, and Africa at the time of the Roman Empire.

The Old Silk Road

The old Silk Route network ran from China, through Siberia in the North, and through Central Asia, Persia, and the Caspian Sea area in the South, and included routes to Southeast Asia, Indonesia, India, and the Eastern coast of Africa.

Flourishing trading cities developed along this Silk Road network, like pearls on a necklace, including in Central Asia such legendary centers of the Islamic Renaissance as Bukhara and Samarkand. The Silk Road was the meeting-place of the great civilizations, cultures, and religions, all the way from ancient times into the period of the Mongol invasions of the 13th century, and to some extent continuing up to the emergence of the British Empire.

The Silk Road is still like a magic word in the ears of people in China and Central and Southern Asia. When the Chinese talk about developing high-speed rail and maglev lines to Europe as a New Silk Road, they mean this very seriously. After the disaster of the so-called Cultural Revolution, the long historical memory of China's intellectual elite is coming once again to the fore.

The concept of a New Silk Road is also exerting a strong influence in another key nation of Southern Asia—Iran. At the Beijing symposium, Iranian Deputy Foreign Minister Broujerji emphasized the key importance of a newly completed, 300-kilometer-long railroad between Meshed in Iran and Tajan in Turkmenistan. That line fills the last remaining gap in a Southern Land Bridge, running from China through Kazakhstan, Uzbekistan, Iran, and Turkey into Southern Europe.

Broujerji also spoke of numerous other regional infrastructure, industry, and agricultural projects, which, taken together, constitute a virtual economic revolution in that part of the world. Naturally, the huge oil and gas deposits of the Caspian Sea region are part of the picture. But, it is notable that Iran is trying to develop the national and regional economy away from a one-sided dependence on petroleum exports, and toward an all-round industrialization based on modern technology.

China is obviously supporting this policy. In fact, in the weeks and months following the Beijing symposium, Iran, China, and other nations have been involved in hectic diplomatic and business activity, trying to solidify the New Silk Road perspective in the form of long-term cooperation and joint projects. Turkey has also been pulled into this process, as well as the nations of the Indian subcontinent.

Given the enormous strategic and economic importance of the Eurasian Land Bridge developments, it is rather curious to observe, how little attention has been given to them in the European and U.S. press. The United States, for example, stands to benefit greatly from a continuing economic boom in Asia—and it is by no means "science fiction" to foresee rail and maglev connections between the Eurasian Landbridge system and North America. In fact, designs are already under discussion for a tunnel under the Bering Straits, linking Alaska with the Russian rail system.

The Era of the Land Bridge has indeed begun!

PART 1

High-Tech Development Corridors: Motor for Eurasian Development

by Jonathan Tennenbaum

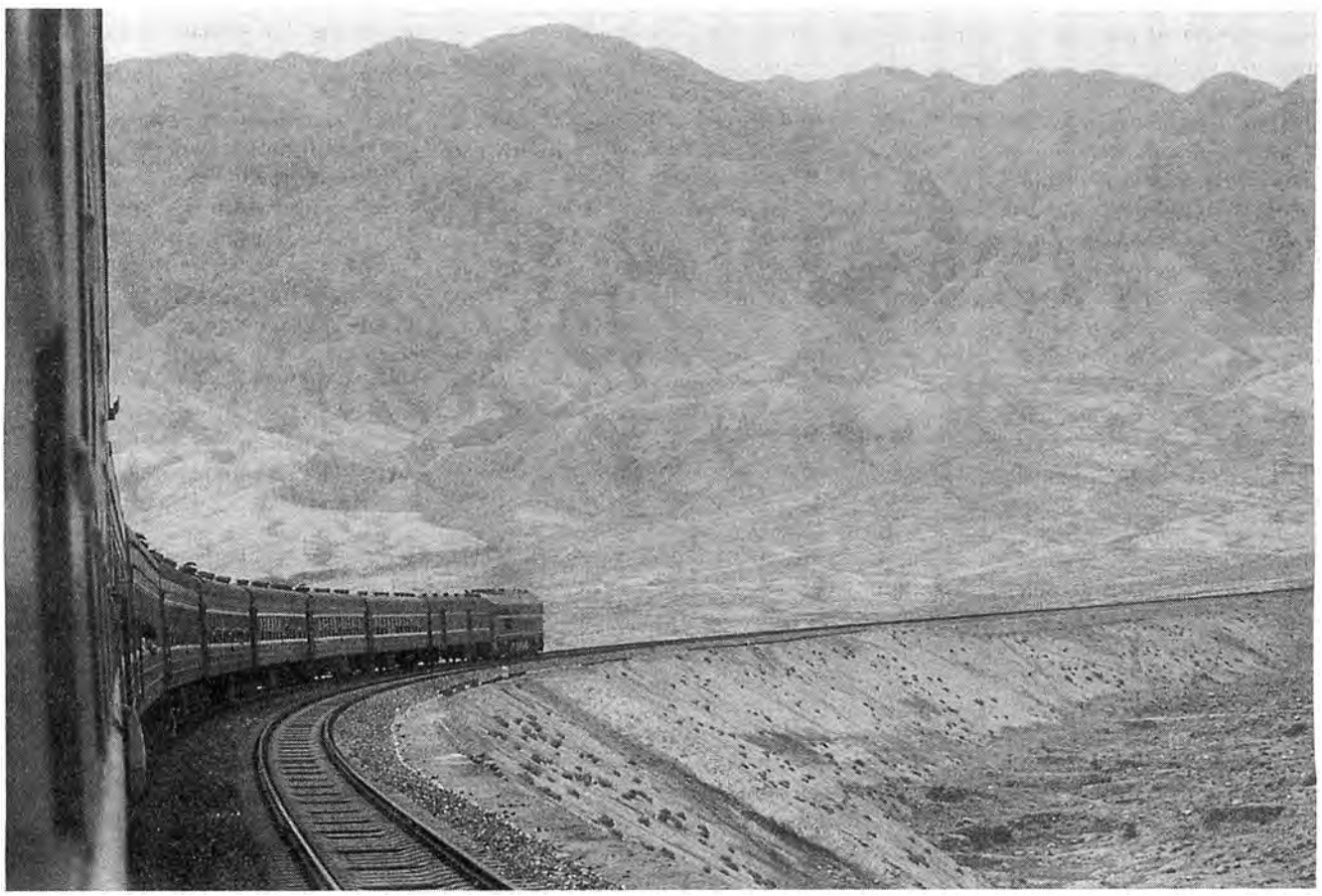
This two-part report is excerpted from a 232-page German-language document on the Eurasian Land Bridge, "The New Silk Road As the Motor of Worldwide Economic Development: Alternative to Globalization and Post-industrial Unemployment," published by Executive Intelligence Review *in November. The report includes translations of major speeches from the May 1996 symposium on this subject held in Beijing.*

Part 2, which will appear in the next issue of 21st Century, *reviews the new technologies envisioned for the development corridors, including maglev railways, ships with magnetohydrodynamic propulsion, high-temperature nuclear reactors, large-scale seawater desalination, and use of hydrogen fuel.*

An English-language version of the document will soon be issued by Executive Intelligence Review. *For more information, write EIR, P.O. Box 17390, Washington, D.C. 20041-0390.*

China's "New Silk Road" initiative has the potential to ignite a process of rapid economic development—a true "economic miracle"—throughout the entire length and breadth of Eurasia. To understand fully what that means, it is necessary to look at the entire system of "development corridors," which will be the main vehicle of Eurasian development in the coming decades.

The locations of these corridors are basically determined by considerations



Lanzhou Railroad Bureau

Many rail lines in China traverse difficult terrain. Here, the landscape along the main section near Lanxin in northwest China.

of economic geography and physical economy. Most of them have a long history, going back thousands of years to the ancient overland trading routes which linked the civilizations and population centers of China, India, the Middle and Near East, Europe, and Africa. Indeed, the famous "Silk Route" of ancient times was only part of a Eurasian-wide trading network, which extended into the North and included the so-called Fur Routes in Siberia.

From the earliest times, the history of the great trading routes was connected with the development of *cities,* promoting the spread of knowledge and culture over the entire, vast area. One of the most notable events in that long history, was the great city-building campaign of Alexander the Great, which extended from the Mediterranean into Central Asia, all the way to the Indus Valley. Not surprisingly, Alexander's military exploits (as countless others before and after him) tended to follow the already established pattern of roads and trade routes.

The present distribution of population-density in Eurasia reflects the combined effect of the natural corridors formed by major rivers and coastlines *and* the "artificial" corridors formed by the old trade routes, and (in recent times) by man-made canals, roads, and railroads. It is a remarkable and highly significant fact, emerging from the millennia-long evolution of Eurasian civilization, that some 25 percent of the entire population of Eurasia, and 70 percent of its urban population, are concentrated within only three main transport corridors, each 100 km wide, connecting Europe with China.

The enormous economic importance of this fact should be evident even to the most simple-minded salesman: Every infrastructural improvement in these three main corridors, means immediate access to a potential "market" of 800 million persons! More generally, concentrating investment into modern transport, energy, water, and communications infrastructure within these corridors, provides the most efficient means to develop the economy of Eurasia as a whole.

Here *technology* plays a crucial role, as the development of railroads demonstrates.

While transcontinental trade has always involved a combination of land and sea transport, the relative importance of these modes has often shifted under the influence of political and technological changes. Aside from the invention of the wheel itself, it was the 19th century emergence of railroads, which brought the greatest revolution in overland transport. Without railroads, the industrial development of Eurasia would have been impossible. Not only did railroads greatly increase the speed and efficiency of land transport, but they, for the first time, provided the means to open up the landlocked interior regions of the continents—the vast hinterlands—for rapid economic development.

Intercontinental Railroad Network

This was demonstrated in the most spectacular manner by the history of the United States, where the world's first transcontinental railroad was built. With North America as a precedent and inspiration, it was not long before the idea of an *intercontinental railroad network* linking Europe, Asia, and Africa, began to take concrete form. It was clear, that the creation of such a network would entirely revolutionize the economic and political map of Eurasia.

We shall not go into that fascinating and turbulent history here, except to note the fact, that the creation of an intercontinental rail network in Eurasia has been bitterly opposed, as a *casus belli,* by the British Empire, from the very beginning until the present day. In fact, as we document in another section of this report, the British and British-allied oligarchical opposition to Euro-Asian and Euro-African railroad development has been a chief—if not *the* chief—cause of two world wars and a decades-long "cold war" in the 20th century.

As a result of such geopolitical manipulation, more than 100 years after the completion of the Atlantic-to-Pacific railroad in the United States, only a *single* transcontinental line has been actually realized in Eurasia: the famous Paris-Vladivostok link via the Trans-Siberian railroad. Although railroads were constructed at various times along major sections of the other corridors, until most recently, crucial gaps in a unified Eurasian system, have remained unfilled.

Now, with the collapse of the Soviet Union and the subsequent completion of the missing rail links from China to Kazakhstan (1990), and Iran to Turkmenistan (1996), we have reached a turning point in the struggle to create an integrated, transcontinental railroad network for Eurasia as a whole. There now exist no less than three major rail lines by which goods can be transported from the Pacific coast of Asia to the Atlantic coast of Europe:

(1) The long-established "Northern Route" via the Trans-Siberian Railroad; (2) the "Middle Route" via the new "Eurasian Bridge" line from China to Kazakhstan, and northward via Moscow, Warsaw, and Berlin to Rotterdam; (3) the "Southern Route" from China through Kazakhstan, Uzbekistan, and Turkmenistan, then via the newly completed connecting link into Iran, and from there through Turkey into the Balkans and central Europe.

Bearing in mind the size of populations which are directly and indirectly linked by the "Eurasian Bridges"—more than 500 million in Europe, and more than 4 billion in rapidly developing areas of East and South Asia—these lines are destined in the future to carry enormous quantities of freight. The mere opening of these "Middle" and "Southern" rail routes, represents only the beginning of the creation of a vast, modern transcontinental railroad system.

National and international rail authorities are already projecting, and are, in part, implementing plans for large-scale modernization of existing track, for multiple-tracking and electrifying existing routes, and for the construction of additional lines. Of greatest economic and strategic importance is to integrate India, with its population of 900 million, to Iran and Central Asia in the West, and to China and Southeast Asia in the East. In addition, there are plans to upgrade the "Northern Route" through additional Siberian rail lines, and to construct land connections to Japan via Sakhalin Island, and to North America via a Bering Straits tunnel. A further, important topic is the future role of revolutionary magnetic levitation technology. . . .

The key to the economic future of Eurasia, however, lies not in the mere creation of efficient transcontinental rail and other transport lines, but rather in transforming these lines (and certain others which must be added) into what we call "infrastructure development corridors," thereby unleashing probably

Lianyungang Eurasian Land Bridge Working Office

The containerized port at Lianyungang, the east end of the Eurasian continental land bridge.

the most intense period of large-scale investment, city-building and agro-industrial development in the history of mankind.

To fully understand the concept and economic function of "infrastructure corridors," let us first focus on the problems posed by any attempt to develop the vast hinterland areas traversed by the transcontinental rail lines—areas for the most part characterized by low pop*ulation* density and difficult natural conditions.

The Problem of Underpopulation

The massive promotion of Malthusian and neo-Malthusian ideas over the last two decades, by the Club of Rome and other powerful sponsors of the radical environmentalist movement, has planted in most people's minds a completely false notion of the relation between population and economic development. Contrary to popularized belief, it is not "overpopulation" which is hindering economic development, but rather the *lack of sufficient population* throughout most of Africa, North and South America, Australia, and even Eurasia itself!

. . . Most of the Earth's land surface is very thinly populated. Apart from scattered, isolated spots, there are only a few extended regions in the world, where the average population density is comparable to that of Central and Western Europe. These are: (1) parts of China, particularly the Huang He and Chang Jiang river valleys, plus parts of Korea and Japan, and Java in Indonesia; (2) parts of India, including the Indus valley and coastal regions of India (3) the Northwest Coast and part of the Great Lakes region of the United States. Otherwise, the Earth is generally a very lonely place.

Leaving aside for the moment the role of climate, natural resources, and so forth, there is a very simple reason, why low population density constitutes a *negative* economic factor. Just consider the *real, material costs per capita* of maintaining any given population at any given level of productive activity and living standard. A major part of that cost consists of the functioning and maintainance of *basic economic infrastructure,* including: transport of persons and goods; construction and maintainance of roads, railroads, public transportation, automobiles, and so on; production and distribution of various forms of energy; water supply and sanitation systems; communications; and health and education systems.

Take a unit population (for example, 1 million persons), and compare the estimated, average costs *per person and per family,* to supply such infrastructural services, in two hypothetical cases: (a) the given population is concentrated in a few, well-designed cities; or (b) the population is spread out evenly over a large rural area. When we make that comparison, we immediately realize why *cities* are one of the greatest inventions of mankind.

The vastly higher *economic efficiency* of cities is most obviously connected with three main factors: First and most obvious, is the drastic reduction in the average distances over which persons, goods, and services must be transported and distributed, to provide any given level of living standard, education, employment, and social-cultural activity. The second is the more intense and more efficient utilization of every sort of facility, from roads and other transport systems, to schools and hospitals. The third factor is the uniquely favorable conditions which urban centers provide for the development and utilization of *technology.*

A typical example is the "electricity revolution" of the late 19th century, which began in the cities and only gradually spread beyond them, generally as the result of dirigistic policies of "rural electrification."

This third factor deserves an additional comment. As Lyndon LaRouche has pointed out, a key characteristic of technological progress is the increase in (what is commonly measured as) *energy flux density* or *power density* of machines and other technical processes, whereby (generally speaking) more useful work can be accomplished with a relatively smaller expenditure of labor, materials, and land area per unit output.

This parameter coheres directly with increase in the potential density of population and the levels of living standard and per capita economic activity which can be sustained, per unit area, at any given technological level. So, we can say that—given favorable economic and

related policies—advances in technology cause increases in the potential population density and, conversely, increased concentration of population and economic activity stimulates and promotes the progress of technology.

All of this holds true, of course, not only for cities and large towns, but also for other forms of concentration of population, such as that along rivers and trade routes of past times. It is also true for the economies of entire nations. If we compare, for example, the relative energy efficiencies of the U.S., German, and Japanese economies during the relatively prosperous period of 1980, we find that in order to maintain a (very roughly) comparable standard of health, living standards, and industrial activity, the Japanese economy required the least expenditure of *energy per capita,* but at the same time had the *highest density of energy use per square kilometer.* The Japanese economy has profited from the advantage of greater *density.*

The same principles apply today to the creation of "infrastructure development corridors."

Infrastructure Corridors

For purposes of conceptualization, the typical "infrastructure corridor" can be visualized as a continuous strip of land, approximately 100 kilometers wide, centered on a major inland transport route, such as a "Eurasian Landbridge" railroad line.

Now, parallel to the rail line, install high-capacity electric power lines, oil and gas pipelines, water supply systems (including possibly major irrigation canals and aqueducts), fiber optic communication lines, and so forth. In this way, we have already created the most essential precondition for every kind of industrial, mining, agriculture, and urban construction activity within the corridor.

Any region in the corridor is not more than about 50 kilometers distant from these main infrastructural "arteries." Hence, it is a simple and economically highly efficient matter, to "grow out" a network of "branches" and "capillaries," connecting to the central infrastructural arteries, and supplying transport, energy, water, and communication services to any part of the corridor, as development requires.

In practice, most of the basic "arteries" and related infrastructure for a typical development corridor will be financed by state investments and Hamiltonian state credits, possibly with the help of international development banks along the lines proposed by Lyndon LaRouche. Construction of infrastructure "capillaries" will often be the function of local and regional governments. Investment, credit, tax, and state regulation policies will be directed at creating the optimal conditions for the creation of modern farms, industries, and new urban centers within the corridor.

Schiller Institute

The author (right) with Helga Zepp-LaRouche (center) and Mary Burdman (left) visiting a farming village in Hebei Province.

Eventually, the result will be a "pearl chain" of beautiful cities and towns, surrounded by regions of intensive agriculture, gardening, forestry, and recreational areas, interspersed with smaller towns and villages.

An additional consideration is crucial to understanding the unique economic advantages of such corridor development. By transforming long-distance lines of transport, energy, or water infrastructure into "development corridors," we vastly increase the efficiency and economic impact of the infrastructure lines themselves.

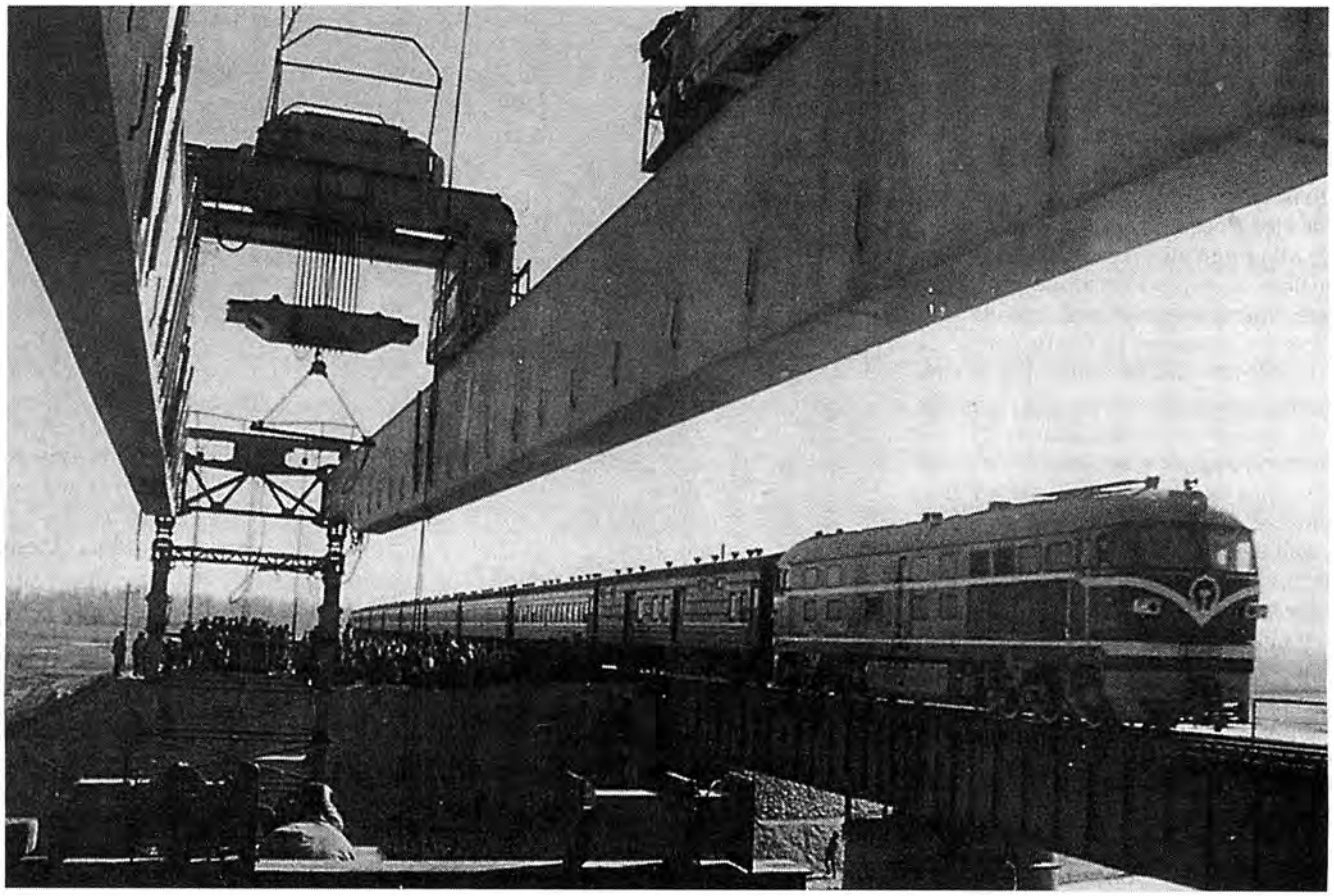
Consider, for example, the construction and operation of a long-distance railroad line linking two cities, *A* and *B,* across a large underdeveloped and underpopulated area. As long as the regions along the railroad line remain underdeveloped, they appear only as a *cost factor* in providing for the transportation of goods and persons between points *A* and *B.* The time and effort spent in traversing the distance between *A* and *B* is simply lost, with no positive economic effect.

In fact, one of the major weaknesses of the economy of the former Soviet Union, was the enormous transport costs incurred as a result of having to link isolated raw materials deposits and processing and production centers, separated from each other by immense, relatively empty spaces.

What happens, however, when we develop a dense fabric of population centers and agricultural and industrial activities located along the entire length of a rail line? In that case, the distance *AB* is transformed into an economic multiplier. Immediately, the degree of utilization of the railroad and other infrastructure is greatly increased.

A Question of Density

Although the addition of local and regional traffic may require adding additional track lanes and making various other improvements, the general rule holds true: The larger the density of exploitation of a transit route, the more efficient the transport system becomes; that is, the lower the investment and operating cost per ton and per ton-kilometer transported. The region along the line is both a large market, and a large supplier of goods. In particular, industries located between *A* and *B,* can process certain goods and materials, transported along the line, into higher-value goods for further shipment to *A, B,* or other locations. By this kind of development, the railroad between *A* and *B* takes on the



Lanzhou Railroad Bureau

Construction of a new railway bridge in China. In the past 10 years, more than 2,000 km of the northwest rail line in China has been double-tracked, large sections electrified, and numerous branches constructed.

role of a giant production line, in which value is added to a portion of the goods as they move from one point to the other. An analogous effect occurs in passenger transport, when passengers exploit the possibility of making a stopover, to conduct some useful business in an intermediate location.

(Those readers familiar with modern physics will recognize the similarity of principle with the functioning of a laser amplifier, and with the phenomenon sometimes called superradiance in an amplifying medium.)

In summary, the unique economic advantages of infrastructure corridors derive mainly from the positive feedback of two factors, both reflecting the impact of LaRouche's density functions:

(1) the bundling of transport, energy, water, communications, and other basic infrastructure along a given route, provides ideal conditions for the growth of a band of intense agriculture, industrial and population centers along that route; and conversely,

(2) the growth in scale and density of economic activity along the entire length of such a route, greatly increases the efficiency, productivity, and the net positive economic effect of infrastructure improvements, as well as every other sort of productive investment.

The extremely high economic efficiencies attained by infrastructure development corridors, give us a uniquely powerful way to overcome the disadvantages of unfavorable natural conditions and (initially) low population densities in much of the vast hinterlands of Eurasia. Whether in the Arctic expanses of Siberia, or in the deserts of Central Asia, it is the availability of abundant electricity, fuels, water, and other essential materials, plus efficient access to the outside world via modern transport and communication links, which largely determine the viability of any investment.

Obviously, therefore, a *continuous corridor of development,* formed in such a way, is economically much more viable than an isolated island or oasis of investment activity. These advantages become even greater, when the corridor in question coincides with, or is closely linked to, a major axis of transcontinental transport, energy supply, and communications for Eurasia as a whole.

The Historical Genesis

The essential conception of the infrastructure corridor, as elaborated here, is based on the work of economist Lyndon H. LaRouche, Jr., and has been an integral feature of LaRouche's approach to economic development policy for a long time. The crucial importance of developing transcontinental infrastructure corridors for the future Eurasia came to the forefront beginning 1988.

In October of that year, LaRouche gave an historic press conference at the Kempinski Hotel in West Berlin, at which he predicted the imminent collapse of the Soviet Union and spoke of the key role of a reunified Germany for the economic reconstruction of Eastern Europe, beginning with Poland.

In the subsequent period, LaRouche began to focus on the construction of modern, high-speed railroads as a key element of any economic reconstruction program. In the first instance, East-West railroad lines would provide the most efficient means to deliver urgently needed economic assistance to Eastern Europe, including especially high-technology capital goods to modernize and rebuild agriculture, industry, and infrastructure in those countries.

LaRouche's elaboration of an economic reconstruction program for Eastern Europe took a definitive form in his 1989 proposal for what became known as the Productive Triangle Paris-Berlin-Vienna. This Productive Triangle would be linked to the rest of the European economy, and eastward into Russia, Ukraine, and so forth, by an array of *corridors* which LaRouche called *spiral arms,* in analogy with the arms of a spiral galaxy. By concentrating investment in a crash program to develop a highly efficient, ultra-modern infrastructure network within the Triangle and its spiral arms, we transform that "galactic system" into the most powerful locomotive for global economic recovery and reconstruction.

LaRouche's Productive Triangle program, as elaborated by a team of economic collaborators, was published in fall 1990 in several languages and disseminated widely, throughout the period 1990-1992. The original program identified three major spiral arms leading eastward in the direction of Asia: (1) the arm Paris-Berlin-Warsaw-Minsk-Moscow; (2) an arm running via Kiev into the Donetsk industrial region of Eastern Ukraine; and (3) an arm leading into the Balkans and Black Sea areas, including the connection to Istanbul and the Near East.

To the West, spiral arms stretch through France and Spain to the Mediterranean coast, and via a projected bridge or tunnel across the Gibraltar Strait into North Africa.

The spiral arms of LaRouche's Productive Triangle program thus already represented the beginnings of a Eurasian and Euro-African system of transcontinental development corridors. At the initiative of LaRouche, the *Executive Intelligence Review* published in October 1992 a proposal for a Eurasian Infrastructure Alliance, centered on the construction of high-speed railroad lines running from the European Triangle to the Pacific Coast of China. That proposal called for the projected rail lines to be used as the backbone for an array of transcontinental infrastructure development corridors, which would include more than one-quarter of the total population and a large majority of the main urban-industrial centers of Europe and Asia.

In the subsequent period, LaRouche and his collaborators gave enormous circulation to the concept of developing Eurasia by high-speed rail systems and other infrastructure. This included a worldwide campaign of publications, public conferences and seminars, and private discussions. . . .

Advanced Technology Required

The creation of a transcontinental system of development corridors means one of the greatest periods of large-scale infrastructure construction in all of human history. Provided that the most modern, efficient technologies are used throughout, it will also be one of the most profitable investments in history, as measured in terms of the resulting, gigantic increase in the production and consumption of useful physical wealth in the participating nations.

Not only are advanced infrastructure technologies the most efficient—when used in a "dense corridor" mode—but the construction, maintenance, and operation of high-technology infrastructure systems provides one of the most effective means to disseminate advanced technologies into the national economies of the participating nations. Once established, the system of development corridors will continue to function as a transmission belt for the spread of scientific and technological progress throughout Eurasia.

Building up countless new cities and new agricultural and industrial regions, within the more that 6 million square kilometers of the Eurasian corridors, and in the surrounding regions, provides a huge field for experimentation and development for every sort of new technology. However modest the beginnings of such corridors may appear in some underdeveloped regions, infrastructure planning must take into account the rapid increase in the scale and intensity of economic activity, which is bound to occur throughout the system, as the effects of the present crisis are overcome.

Physical Economy Criteria

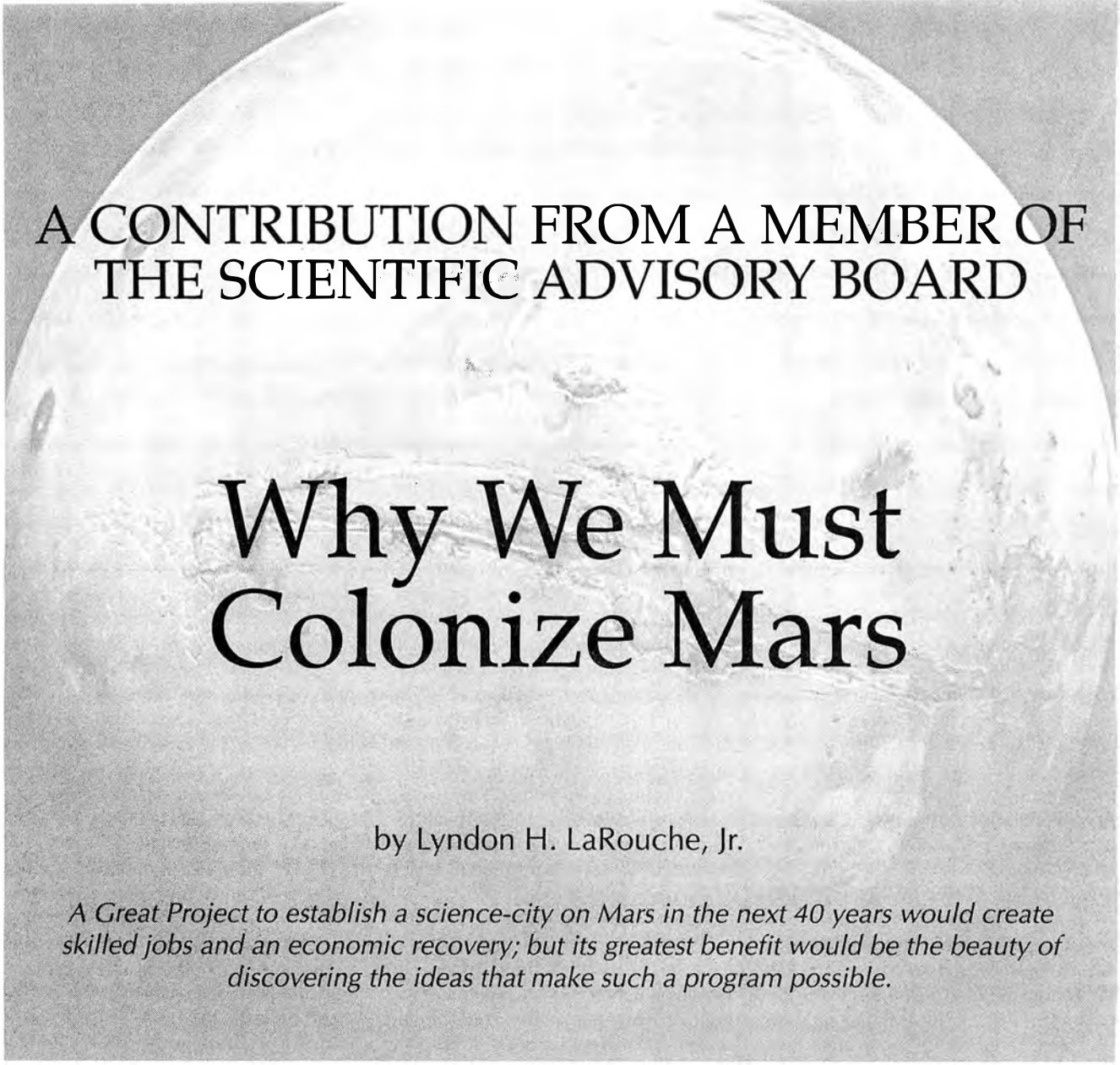
In order for the infrastructure corridors to function effectively as an economic locomotive for Eurasia as a whole, it is necessary to employ rigorous criteria of physical economy for the choice of the chief technologies to be used in the transport, energy, water, and communications systems of these corridors. Chief among these are:

(1) The average per capita and per square kilometer parameters of infrastructure performance must attain values comparable to (and later exceeding), those of Japan prior to the present economic crisis, throughout the interior region of the Eurasian corridors. These parameters include: supply of electricity, heat, and essential fuels, per capita and per square km; supply of household, industrial, and agricultural water, per capita and per square km; performance of transport systems, in ton-kilometers and value-ton-km per hour, per capita and per square km; and comparable parameters for communications systems, as well as availability of health and educational services.

(2) Technologies must be chosen in order to provide the relatively highest *density of performance,* in terms of useful infrastructural performance per unit of land area, per employed worker, and per other resources consumed by the given infrastructural system. This potential of a technology to provide higher performance density correlates broadly with the *energy flux density* or *power density* of that technology, as measured in watts per centimeter of power flow through the crucial work surfaces of the process involved.

(3) "Technological quality" must increase, as reflected in such parameters as the quality or "tuning" of energy (for example, electricity versus thermal power, high temperature heat versus low temperature heat, coherent versus incoherent electromagnetic radiation, short-wavelength versus long-wavelength radiation, and so on), increasing speed of passenger transport, and so on.

(4) Infrastructure systems must be designed in such a way, as to permit upgrading of system-capacities, as well as introduction of more advanced technology, as the infrastructure corridors develop.



A CONTRIBUTION FROM A MEMBER OF THE SCIENTIFIC ADVISORY BOARD

Why We Must Colonize Mars

by Lyndon H. LaRouche, Jr.

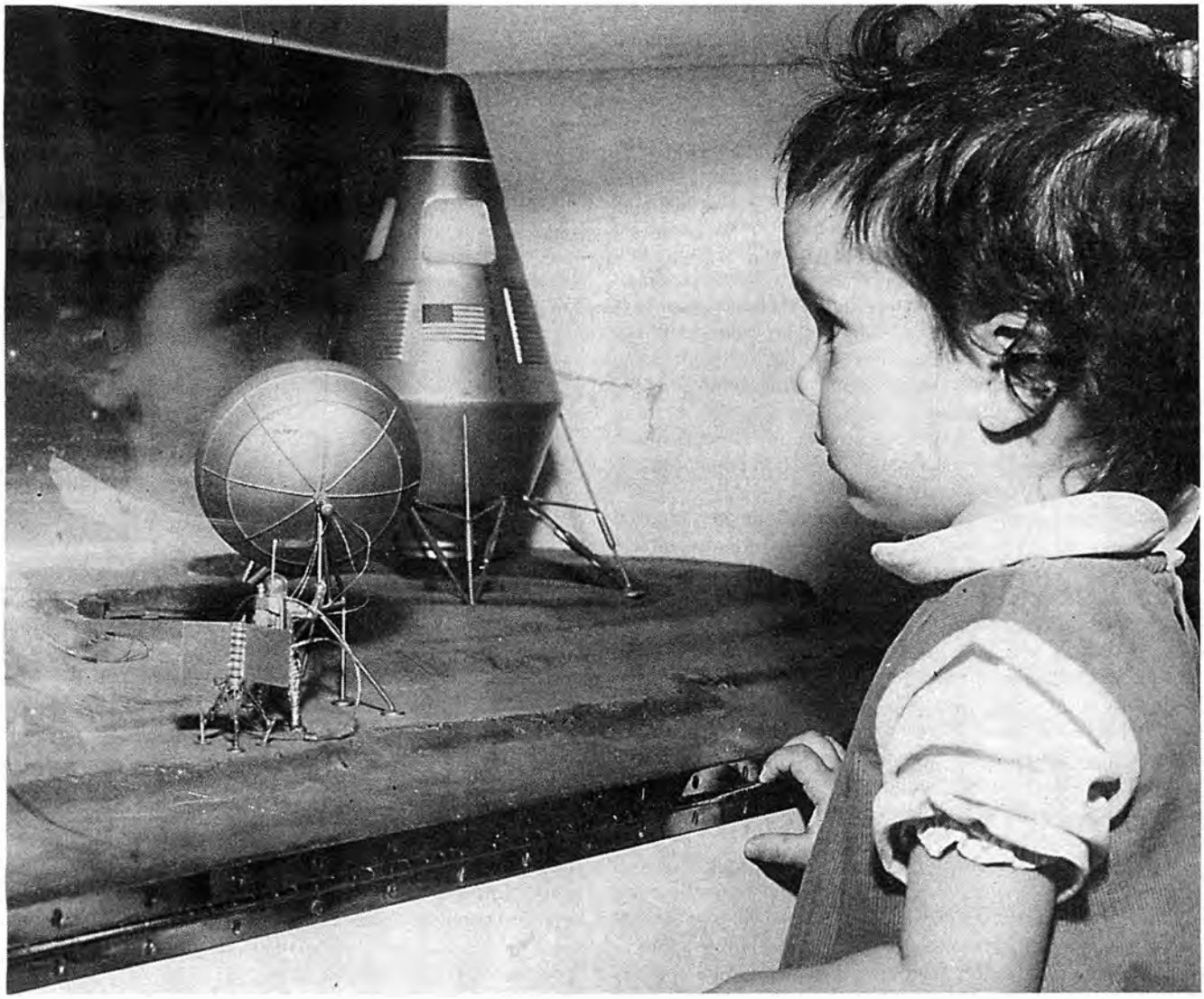
A Great Project to establish a science-city on Mars in the next 40 years would create skilled jobs and an economic recovery; but its greatest benefit would be the beauty of discovering the ideas that make such a program possible.

My commitment to designing a new policy of Moon-Mars colonization for the United States, began during the early spring of 1985, as I prepared the address I was assigned to deliver at a June 15-16, 1985, Schiller Institute Conference, dedicated to honor the memory of our recently deceased friend, veteran space pioneer Krafft Ehricke.[1] At that time, it appeared to me that the appropriate way in which to remember Krafft as I had known him, was to ensure the furtherance of that goal which he had devoted so much to bring about: the use of our Moon as the industrial base from which to launch the future colonization of Mars. In light of my relevant special competencies as a physical economist, and my earlier work on what was then known as U.S. President Ronald Reagan's Strategic Defense Initiative (SDI),[2] I had something unique and important to offer on the subject of such a Mars-colonization project.

Weeks later, exchanges with conference participants, during the discussion panel, led to my commitment to amplify my proposal. This, in turn, led to my February-March 1986 public submission of my design for a 40-year program leading to colonization of Mars.[3] Much later, I updated that proposal in sundry ways, including a draft motion-picture script, *The Woman on Mars,* [see pp. 30-41] which I composed with the intent that it serve as a dramatic vehicle for documenting the successive stages leading into the opening of the first science-city colony on Mars, after 40 preparatory years. An abbreviated version of that script, was the basis for a half-hour television network broadcast, as part of my 1988 campaign for the Democratic Party's U.S. Presidential nomination.[4]

All of this occurred against the backdrop of the "back-channel," exploratory discussions which I had conducted, during 1982 and early 1983, on behalf of our government, with a Soviet channel. The "Mars Colonization" policy was seen by me as a way of circumventing the effects of the stubborn Soviet rejection of President Reagan's offer of March 23, 1983.

As I had reported, both to the Soviet channel, and to the relevant officials in the U.S. National Security Council, my leading concerns in those discussions, were three: (1) the risk of thermonuclear war inherent in so-called "detente" agreements; (2) the accelerating decline of the world economy since 1970-



NASA

A youngster contemplates a model of a nuclear-propelled Mars lander, at the Nuclear Rocket Development Station in Nevada in 1966, during a Science Youth Day.

1971; and, (3) my judgment, as stated to both my Soviet and U.S. channels during February 1983, that the Soviet economy was currently headed for a collapse, approximately five years ahead. The strategic objective built into my design for "strategic ballistic missile defense, based upon 'new physical principles,'" was to realize the urgently needed, combined, global, economic, and political benefits of a "science-driver" program. It was essential to reverse the ongoing, and, then, already far advanced trend, toward a worldwide physical-economic collapse, and to prevent, thus, the collapse into the kinds of cultural pessimism which would almost certainly produce new forms of fascism in the "West," and the probable degeneration of an economically collapsed, and demoralized Russia into a Dostoevskyian, "Third Rome" nightmare.

The hysterical rejection of the SDI, first from General Secretary Yuri Andropov, and, later, from the Gorbachev regime,

1. *Colonize Space! Open the Age of Reason*, Proceedings of the Krafft A. Ehricke Memorial Conference of June 1985 (New York: New Benjamin Franklin House, 1985). This international conference was convened in Reston, Virginia, during June 15-16, 1985, sponsored jointly by the Fusion Energy Foundation and the Schiller Institute. Krafft Ehricke had died in December 1984.
2. The initial form of the SDI, as summarized in the approximately 5-minute, relevant segment of President Reagan's nationwide televised address of March 23, 1983, was a policy which I had featured as part of my 1980 candidacy for the U.S. Presidential nomination of the Democratic Party. Later, during the 12 months beginning mid-February 1982, my proposal for strategic ballistic missile defense, served as the principal talking-point of an exploratory "back-channel" chat with the Soviet government which I conducted on behalf of the Reagan Presidency. Apparently, the President liked what was reported to him from those "back channel" discussions; his televised announcement of March 23, 1983 echoed every principal policy-feature of the design which I had outlined to the Soviets, point by point. Later, the SDI underwent mutilating modifications, but it was the March 23, 1983, confirmation of my outlined policy which stuck in the Soviet mind.
3. This was subsequently printed by the Fusion Energy Foundation, and was circulated, at a later time, at the event at which the Paine Commission presented its own proposal for a long-range Mars exploration project. A comparison, and contrast of the similarities and differences between the two designs, is a fruitful approach to understanding the policy issues such a long-range undertaking ought to provoke.
4. *The Woman on Mars*, sponsored by The LaRouche Democratic Campaign, was broadcast March 3, 1988.

prompted me to judge, in spring 1985, that cooperation in a 40-year science-driver program to prepare the colonization of Mars, was the only visible alternative which might be proposed under those circumstances.

The Comecon system collapsed in about six years, not the five which I had foreseen in 1983. Not only have both the Comecon and the Soviet Union dissolved; since 1988, there have been sweeping changes in institutions throughout most of the world. The world is a far worse place, a more dangerous place, a vastly poorer place to live today, than in 1983, 1986, or 1989. As of the present moment of writing, the managing director of the International Monetary Fund, Michael Camdessus, has come around recently to agreement with at least one key element of my general economic forecast: that the international monetary system is gripped by a systemic crisis, centered in the banking system, which could collapse the entire system, in an implosive, reversed-leverage chain-reaction. He appears to agree with my estimate, that that chain-reaction collapse could break out at almost any moment.[5]

Today, most among our financial institutions are managed by the species of madmen which makes riverboat gamblers seem paragons of prudence and moral rectitude, by comparison. Our basic economic infrastructure, our ruined farms, our lost industries, our collapsing family standard of living, have been destroyed, as tribute to the fires of a monetarist Moloch. In the United States, the net physical market-basket of consumption and output, per capita of labor-force, is approximately half what it was 25 years ago.[6] A similar situation prevails in today's Western Europe. In Eastern Europe, the territory of the former Soviet Union, and other regions of today's looted Third World, the physical realities of economic life are beyond mere desperation.[7]

To say, that we could not afford a space-program at this time, is the opinion of a person who shows no comprehension of the world's present economic crisis. For the very reason that more and more of the world's people can no longer afford to eat, a Mars-colonization science-driver, economic-recovery program, is a far more urgent need of this planet, a far more practical undertaking, than it was back during 1985-1986, when I developed my initial proposals on this subject.

Unfortunately, aging has overtaken all of the great space-pioneers of this century. Only among a minority of "Baby Boomers," and a larger ration of those of retirement age, does our population have as much as a faint recollection of the joy which surged through our population with the first landing of men on the Moon; for many of our people, that was the next to last time the news broadcasts gave them good reason to be happy. Today's situation in space policy, is comparable to the state of affairs, that medical science and public sanitation had been, finally, successfully eradicated by today's insurance cartels, at the time history's greatest wave of pandemics had seized our planet. Virtually, we must teach the world the principles, purposes, and benefits of the almost-lost science of space exploration, all over again.

5. John Hoefle, "IMF admits global banking crisis is out of control," *Executive Intelligence Review (EIR)*, Oct. 11, 1996; Lyons G-7 summit: *EIR*, July 19, 1996, pp. 14-31.
6. Christopher White, "NAM's 'Renaissance' of U.S. Industry: It Never Happened," *EIR*, April 14, 1995; "U.S. Market Basket is Half What It Was in the 1960s," *EIR*, Sept. 27, 1996.
7. *EIR*, May 31, 1996, pp. 4-65.

"For the very reason that more and more of the world's people can no longer afford to eat, a Mars-colonization science-driver, economic-recovery program, is a far more urgent need of this planet, a far more practical undertaking, than it was back during 1985-1986, when I developed my initial proposals on this subject." Here, the author addresses the Krafft Ehricke Memorial Conference in June 1985. Helga Zepp-LaRouche is at left.

It is necessary to explain these functional connections: *What is the economic principle which defines a science-driver space-exploration program as key to a successful near-term recovery from the presently deepening, global economic depression?* Let us name this topic, "The Christopher Columbus Principle of Economic Science." The usefulness of that choice of name for this principle, will be made clear below.

Commodities Do Not Produce Commodities

Until the terrible, destructive changes in U.S. policy-shaping, 1966-1979, ours had been a nation in which veterans of World War II could make a revolution in the agriculture of family-operated farms of between 200 and 400 acres. It was a time in which most of the labor-force was employed as either operatives or technologists in some branch of either production of physical goods, or in related employment as operatives or technologists in basic economic infrastructure. Most of the labor-force experienced wealth as the benefit of a productive process. In management, the production executive, with his engineering staff and subordinate line management, thought of products and productive processes in terms of investment in scientific and technological progress, and analyzed the management of pathways and inventories in terms of production-planning tools such as bills of materials and process-sheets. We were a productive-performance society.

Today, that sanity reigns no more.

Since about 1966, we have passed over, from am increasingly healthy and wealthy, production-oriented, "blue collar" society, to a decadent, self-bankrupted, consumption-oriented society of "casual attire" and hedonism: a pathetic, decadent "feel my pain" society, a society besotted with the mystiques

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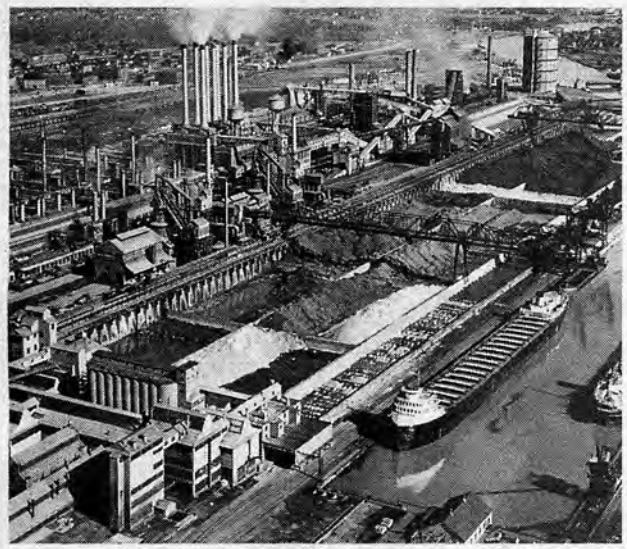

Ford Motor Company

Here, Ford Motor Company's giant Rouge industrial complex in Dearborn, Mich., which was once the largest concentration of manufacturing and assembly operations in the world. Iron ore, limestone, and coal were unloaded on the docks, smelted into iron, converted into steel, and within days, transformed into engines, frames, bodies, and parts—and finally, into completed automobiles.

of "midlife" and "midriff" crises. One should be reminded of the decaying Roman slave-society of the Civil Wars and the Caesars, of parasitical mobs of those citizens who had been degraded into living on the scant rations of political handouts, of a decadent population of Imperial Rome, mobs and all, taking pleasure in the pre-electronic improvisation of our present-day TV entertainments, the Roman Circus Maximus. No person who graduated from university after 1968 ever experienced, during his or her adult life, a time during which the axiomatic assumptions of our nation's economic-policy-shaping were not insane. The thoughtful archeologist might slowly shake his head: He is reminded of dead cultures which had also mislaid the moral fitness to survive.

The added problem, in Europe as in the Americas, is that, during the recent 10 years, most among those who entered the top-most positions of policy-shaping within the most influential governmental and private institutions, were drawn from the world's "Baby Boomer" generation. Therefore, except for a tiny minority of the exceptional among them, the policy-axioms which they regard as "mainstream" verities today, reflect the confines of their childhood, shared with such celebrated moral titans as "Howdy Doody," and with a subsequent adolescent and adult education and experience dating from approximately the middle of the 1960s.

The "Baby Boomers" in today's policy-shaping positions, are not to be blamed for inventing the "cultural paradigm-shift" of the 1966-1972 interval; they are chiefly victims of the 1962-1971 decade of aversive behavioral modification of almost an entire generation.[8] They, as victims of Tavistock Centre mass-conditioning, simply take those innovations for granted, on blind faith, as what they were conditioned to accept decades earlier. The axioms of the present economic policy-shaping are, thus, fairly described as the fashionable things which one should be overheard saying, to promote one's career in politics, in a university post, in business, or, simply in those recreational settings in which self-important people foregather, ostensibly to be admired by others, but, most of all, by themselves.

We who watched that process of behavioral conditioning of the Baby Boomers and others, during the past 30-odd years, must help the leaders of that generation of victims, and of so-called "Generation X," to understand their own predicament. If we fail to do precisely that, those two generations, and more, are as self-doomed as Shakespeare's Hamlet, to come soon to a wretched end, and in a similar fashion. Within the limited specific purview of our subject here, the economics of space-exploration, we must assist today's "Baby Boomers" in understanding the axiomatic incompetence of their parents' generation on the subject of economic principles: the incompetence which is the axiomatic underpinning of so-called "mainstream" economic thinking today.

During the post-war interval, the proverbial "cutting edge" of economic and industrial-management professionalism, was represented by a mid-1950s factional controversy, between two mutually opposing factions in a newly encamped branch of economics teaching. This recent development in taught economics, was known as "systems analysis," or, "input-output analysis." On the one side of the controversy, was (then) Harvard University Professor Wassily Leontief, a principal designer of the U.S. government's post-war National Income and Product accounting system. Opposing Leontief et al., was what Leontief himself aptly identified as the "ivory tower" school of Tjalling Koopmans' Operations Research Society.[9] The U.S. component of this "ivory tower" faction, was permeated with the influence of two devotees of Bertrand Russell, Norbert Wiener (of "information theory" notoriety), and John von Neumann's "systems analysis" dogmas. The mother of the doctrine, internationally, was what came to be known as the Cambridge (England) "Systems Analysis" mafia of such Bertrand Russell successors as Lord Kaldor and his associates.

Although the experimental standpoint of Leontief was much preferable to that of the "ivory tower" fanatics, there was a common axiomatic fallacy underlying both. This significance

8. From the "Cuba Missiles Crisis" and political assassinations of President Kennedy, Malcolm X, Martin Luther King, and Bobby Kennedy, of the Vietnam War performed on nightly television, and of the August 1971 collapse of the Bretton Woods agreements.
9. See reference to this in Lyndon H. LaRouche, Jr., "Kenneth Arrow Runs Out of Ideas, But Not Words," *21st Century Science & Technology*, Fall 1995.

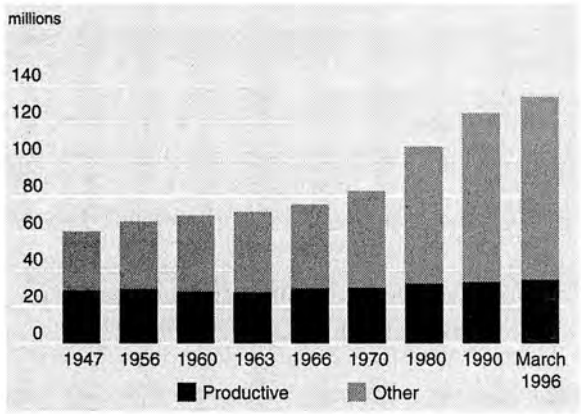

Figure 1
PRODUCTIVE PORTION OF U.S. LABOR FORCE, 1947-1996

The proportion of the labor force that is engaged in productive labor (manufacturing, construction, farming, mining, public utilities, and transportation) has dropped precipitously since the end of World War II. ("Productive" signifies the direct alteration of nature through labor, in order to increase the rate of potential relative population density.) The rest of the labor force ("other") consists of "essential" workers in such fields as health, education, and useful engineering, but also "overhead" workers such as accountants, retail clerks, and lawyers, who are neither productive nor essential to the physical economy. Most new jobs today are in the overhead category.

Source: *Executive Intelligence Review*, Sept. 27, 1996, p. 14

of this pervasive fallacy is put into sharper focus, if from a Cambridge vantage-point, by a small, 1960, book, of British economist Piero Sraffa, *The Production of Commodities by Means of Commodities*.[10] That fallacy is the most stubborn of the underlying, axiomatic morbidities governing virtually all currently "mainstream" economics opinion.

To understand the axiomatic root of the incompetence of today's economics dogmas, it is indispensable, if not sufficient, to recognize the absurdity of studying an economic process from a consumerist, rather than productive standpoint. It is also necessary to recognize that today's popular monetarist illiteracy represents not only the "consumerist" lunacy, but also carries forward the crude errors of axiomatic assumption already embedded in the "input-output analysis" of the 1940s through 1970s. On the latter account, this writer has introduced the pedagogical imagery of the "Columbus Principle." We now quote the relevant pages from the introduction to a new, Chinese-language edition of the writer's 1984 textbook in physical economy.[11]

> The analysis of economy from the standpoint of production, employs statistical tools such as bills of materials and process sheets. Each detail of the network of an economy's total production-cycle, from infrastructure to consumption of finished product, is mapped, as streams, into the junction-points where productive actions are performed. "Market-baskets" of required goods are accounted for, per capita of labor force, per unit of land-area, and per family household. Leibniz's approach to defining a necessary household market-basket, is employed throughout, both for household consumption and for each branch of agriculture, industry, and infrastructure.[12] Allowances are made for sundry forms of administration, in a similar way.
>
> This analysis of the production-stream, faces the economist with the challenge of discovering some notion of functional relationship between variation in the physical contents of these market-baskets and variation in the productive power of labor, per capita, as Leibniz demanded the necessary income of the household of the laborer be studied.[13] We must do this for every branch of production and infrastructure, in addition to study of the required market-baskets of family households.
>
> The immediate goal of such inquiries, is to determine the relationship between the expenditures and the variation in effective productive output of the society, per capita of the employed labor-force. No competent measurement of such a functional relationship can be made in money-prices; the correlation must be between physical inputs and physical productivity of labor. Only one exception to this rule should be permitted: to the degree quantity and quality of education, health-care, and science and technology services affects the potential physical productive powers of labor, those expenditures must be included in the market-baskets of consumption by labor, by infrastructural facilities, by agriculture, and industry.
>
> By those empirical means, we attempt to determine what portion of the consumption by a society corresponds to "energy of the system." We correlate that consumption with a certain level of potential productive output. We assume that any of the non-wasted output in excess of replacing that required consumption, is the "free energy" of the productive process. The economist must account for the role of reinvestment of some portion of that "free energy," both to expand the scale of the economy and its supporting infrastructure, and to increase the productivity of the productive process by emphasis on power-intensive, capital-intensive modes of investment in scientific and technological progress. The economist's goal, is to ensure that the ratio of "free energy" to "energy of the system" does not decline, even though the "energy of the system," per capita, is being increased. The question is, how would changes in the patterns of consumption affect the potential productive powers of labor? How would changes affect the ratio of "free energy" to "energy of the system"?
>
> The apparent cause for the failure of most attempts to understand the physical economy of an entire nation-state in those terms, is the error of assuming that we can

10. Piero Sraffa, *The Production of Commodities by Means of Commodities* (1960).
11. Lyndon H. LaRouche, Jr., *So, You Wish to Learn All About Economics?* 2nd edition (Washington, D.C.: EIR News Service, 1995).
12. G. Leibniz, *Society & Economy* (1671), translated by John Chambless, *Fidelio*, Vol. 1, No. 3 (Fall, 1992), pp. 54-55.
13. *Ibid.*

measure the functional variation in relationship of input to output in such a way as to imply that we are measuring the "production of commodities by commodities," with the human individual serving only as vehicle for such functions. The unscientific character of Norbert Wiener's "information theory," and John von Neumann's attempts to apply his "systems analysis" to economic processes, is a related case. The work on input-output models by Professor Wassily Leontief, is useful, on condition we do not fall into the delusion, of assuming that, in such a configuration, we are studying the implied "production of commodities by commodities."

The source of increase of the productive powers of labor, is the quality of the typical newborn human individual, which sets all persons absolutely apart from, and above all lower forms of life. This distinction is most readily identified, in functional terms of reference, as that developable, but sovereign capability of each human individual mind, for making valid, revolutionary discoveries of physical principle. This applies both to experimentally valid original discoveries of principle, and to the student's reenactment of an original such act of discovery. The same principle of cognition central to fundamental scientific discovery, is the source of all of the masterworks of European Classical art-forms. The increase of the individual person's power over nature, in production and in design of products, is derived from the cultivation of those same cognitive powers from which we obtain advances in scientific and artistic knowledge.

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We must think of products not as the cause of productivity of labor, but as the necessary circumstances of that productivity. Consider the case of Christopher Columbus's discovery of the Americas.[14]

Columbus's discovery of the Americas began toward the close of the third century B.C., with the estimate of the Earth's curvature by the celebrated member of the Platonic Academy at Athens, Eratosthenes. Employing Eratosthenes' and other ancient experiments as his guide, Paolo Toscanelli (1397-1482), the leading astronomer of the 15th century, created the maps of the world which guided Columbus to his successful voyage.[15] Toscanelli's map had but one notable flaw; it was based upon a nearly accurate size of the Earth, as determined by astronomical observations of the Earth's curvature, but, it relied upon the highly exaggerated reports supplied by Venice, on the distances from Venice to China and Japan, placing Japan and the islands of the Indies in the middle of today's United States!

Columbus learned of Toscanelli's maps nearly two decades before his famous voyages of discovery. This included Columbus's access to the correspondence between Toscanelli and Lisbon's Fernao Martins, on the subject of exploration westward across the Atlantic Ocean for the Indies.[16] Columbus wrote to Toscanelli and became fully informed, in the last years of Toscanelli's life, of the collaboration which had been ongoing for decades before, and which had begun with the immediate Florentine circle of Nicholas of Cusa during the years before the Council of Florence of 1439.[17] Columbus added to this scientific knowledge, his experience and knowledge as a navigator for the Portuguese, knowledge of ocean currents and prevailing winds, which clearly implied the probable location of, and route toward land on the other side of the Atlantic. His use of Toscanelli's map, indicates that his original goal were the islands of the Pacific far to the South of Japan. Columbus's discovery of the Americas was, thus, a "scientific discovery," in the strictest meaning of experimental physics.

This example of Columbus's discovery is cited here to illustrate one of the most crucial principles of economic science, a principle apparently unknown to the popular economics doctrines of today's universities. The relevant question is: *Was the discovery of the Americas accomplished by the three ships Columbus commanded, or the sailors on those ships?* Reports of Columbus's difficulties in securing those ships, and the reluctance of the crew, illuminate the twofold fact: *It was Columbus, and he alone, who acted to effect the discovery of the Americas; but, he could not have succeeded without the ships and crew.*

It is not the means of production, or even labor as such, which produces those advances upon which progress in the condition of mankind is effected. It is the power of valid scientific and artistic discovery by the sovereign powers of the individual intellect, upon which all human progress depends. However, to advance, the discoverers, and their associates in labor, must be educated up to the level needed to make valid discoveries and put them into operation. Even those means will not succeed, unless the suitable tools and materials are provided to make effective the impulse of the creative individual intellect.

The ships did not cause the discovery of the Americas, but they were essential to that discovery. The material conditions of life do not generate human progress, but without such means to convey the work of the human intellect, progress is not possible. The point ought to be

14. In rebuttal of those who insist that "Columbus could not have discovered America," because there were already inhabitants of the Americas thousands of years earlier than A.D. 1492, one might mention the case of the wise woman who set a trap by means of which to *discover* another woman in her husband's bed. Columbus's discovery of the Americas was accomplished by the same methods of astrophysics used to discover planets, moons, and asteroids of the Solar System.
15. Gustavo Uzielli, "Paolo Toscanelli, Amerigo Vespucci, e la scoperta d'America," in his book of essays, *Paolo dal Pozzo Toscanelli, initiatore della scoperta d'America. Ricordo del Solstizio d'estate del 1892* (Florence, 1892).
16. *Ibid.*
17. Paolo Emilio Taviani, *Christopher Columbus: The Grand Design* (London: Orbis, 1985); Ricardo Olvera, "The Discovery of the Americas and the Renaissance Scientific Project," *EIR*, Oct. 19, 1990.

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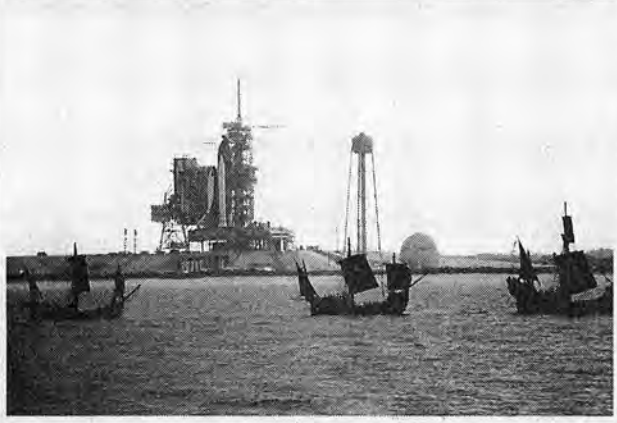


NASA

Sail on Columbus! Replicas of the Santa Maria, Niña, and Pinta sail near the Space Shuttle Endeavour, as it awaits liftoff in May 1992, the year of the 500th anniversary of Columbus's voyage to the New World.

Christopher Columbus, as portrayed in a mosaic by Antonio Salviati in the Palazzo Tussi, Genoa.

obvious, but most professed economists have been too fiercely gripped by the delusions demanded by their adopted ideologies, to recognize the right relations within the productive process.

The same word of caution must be applied to this textbook's treatment of the relations expressed in terms of the social division of physically productive labor. It is not the quantity of persons, or the amount of their labor-time employed, which generates productivity; it is the developed powers of the individual's human intellect, an intellectual power which could not be effective without associated development of basic economic infrastructure and means of production.

Thus, once we have accepted, as a matter of principle, the need for certain preconditions of production, we must concentrate upon the development of the quality of the individual person within society. For example, the amount of time of the child freed for education, will affect the level of development of that child's knowledge and mental powers. To provide a suitable quality of education, even with the best teachers, would not be possible unless the economic standard of household life permitted the young to devote the greater portion of the many years of childhood and adolescence to such education. The health and longevity of the members of the households, is crucial for this. Those social relations and material conditions of family and community life, which are essential to the improved development of the individual personality's scientific and artistic powers, are essential material needs of the household and community, are essential features of the "energy of the system" required to perpetuate a specific, corresponding level of potential productive powers of labor.

Similarly, any society based upon a fixed productive technology, must decay into ruin from the accumulated effects of what we term "technological attrition." Without investment in scientific and technological progress, a society will degenerate. Yet, investment in scientific and technological progress requires increased investment in infrastructure, in improvements in nature, in water consumed per capita, in power consumed per capita, and in tools of production required per capita.

"Any society based upon a fixed productive technology, must decay into ruin from the accumulated effects of what we term 'technological attrition.'"

All survivable economies are characteristically "not entropic" in these terms: *The ratio of "free energy" to "energy of the system" must not decline, despite the imperative increase of the "energy of the system" through "reinvestment" of a portion of the "free energy" flow.* The source of that "not entropic" impulse, is nothing other than that which sets mankind absolutely apart from, and above all other known species in this universe: those creative powers of the individual human mind, by means of which valid, original discoveries of univer-

sal principle are discovered, and that mental act of discovery replicated, by reenactment, within the sovereign precincts of the mental processes of the student.

That "Columbus Principle" is the key to the stunning success of the U.S. 1940-1943 economic mobilization for war, under the leadership of President Franklin Delano Roosevelt. That is the source of Chase Econometrics' estimated $14.00 return to the U.S. economy, for each $1.00 spent by government on the Kennedy Apollo Project. Drive the rate of realization of scientific discoveries of principle to the limit, and mobilize the material, educational, and health resources needed, to enable modern "Christopher Columbuses" to succeed in their voyages of discovery beyond new frontiers. That is the secret of all the great economic achievements of modern western European civilization. The relevant policy, is to promote the development of the mind of as many individual persons as possible, through a method of education consistent with the Christian-humanist models of the Brothers of the Common Life, Friedrich Schiller, and Schiller's follower Wilhelm von Humboldt. One must drive those developed mental capabilities toward their limits of achievement, through providing the appropriate choice of mission and means to bring about fundamental increases of mankind's power over nature, in man's per capita relationship to our universe, as *Genesis* 1:26-28 prescribes.

"The purpose of space-exploration, is not conquering real estate or looting raw materials for Earth; it is making a change in the existing relationship between man and the universe, a change which is necessary for developing new principles essential to the improvement of life here on Earth."

In The Wake of the Santa Maria

During the 1950s, Wernher von Braun acknowledged Christopher Columbus's choice of three ships for the discovery of the Americas, as the appropriate model for mankind's future journey to Mars.[18] In 1986, this writer adopted von Braun's "Columbus Principle," and featured it, as such, within his own designs, that year and later, for a 40-year science-driver program, for preparing the colonization of Mars. Yet, there is another crucial lesson to be adduced from the Columbus Principle, a point with which von Braun would have concurred, at least in substantial degree. How was it that the associates of Cardinal Nicholas of Cusa came to propose that voyage to the Indies which Christopher Columbus adopted from the correspondence of Cusa's associates Paolo Toscanelli and Fernao Martins?[19] As Columbus's sponsor, the noble Queen Isabella insisted: it was not the search for gold and slaves, or other booty from distant places, which was the purpose of her government in sponsoring the exploration.[20] The purpose of space-exploration, is not conquering real estate or looting raw materials for Earth; it is making a change in the existing relationship between man and the universe, a change which is necessary for developing new principles essential to the improvement of life here on Earth.

The primary benefit from space-exploration is the progress of the individual's human condition on Earth itself. This benefit arises from the "spill over," into the Earth's internal economy, of forced-draft breakthroughs in discovery and development of newly discovered principles. This occurs chiefly through the use of the designs of successful proof-of-principle experiments, as models for introducing new design principles into machine-tools and end-products of the productive process in general. In the jargon of the shrewd businessman: "We may lose a great deal of money in exploring space, but we get that back, many times over, from the by-products of the operation."

Then, during the mid-1980s, as now, this writer defined the scientific objectives of science-driver "crash programs" of economic development, in the following rule-of-thumb terms.

We begin, as Nicholas of Cusa did, and Johannes Kepler, Gottfried Leibniz, Carl Gauss, Wilhelm Weber, and Bernhard Riemann after him.[21] We begin by emphasizing the distinction between the useful, but relatively defective formal mathematical physics, and experimental physics.[22] In experimental physics, we repeatedly encounter paradoxes which threaten the authority of any established mathematical physics. The experimental validation of discovered solutions for those paradoxes, presents us with new physical principles. It was the kernel of Riemann's act of genius, in his 1854 habilitation dissertation,[23] to recognize that such principles represent the new "dimensions" of a physical space-time geometry, whose addition creates, thus, a new (Platonic) hypothesis to rule over mathematical physics, a new physical space-time manifold, each such with its own characteristic "curvature." As Riemann apprehended the genius of Gauss's work, it is the experimental measurement of that "curvature" which satisfies Nicholas of

18. For a bibliography of von Braun's published writings on Mars, see Marsha Freeman, *How We Got to The Moon: The Story of the German Space Pioneers* (Washington, D.C.: 21st Century Science Associates, 1993), pp. 352-353.
19. Nicholas of Cusa, the author of the key work in the founding of the modern European nation-state, *De concordantia catholica* (1433), and the founder of modern physical science, as in his *De docta ignorantia* (1441). He contributed a decisive role in organizing the great ecumenical Council of Florence (1439-1441). He was also a key figure in promoting a policy of ecumenicism among Christians, Jews, and Moslems (*De pace fidei*). Cusa designated his close collaborator Fernao Martins to be the executor of his estate. Martins returned to Portugal to assume church duties assigned him there. Thus, the correspondence between Toscanelli and Martins came into the orbit of Columbus's activities as a Portuguese navigator.
20. Isabella forbid the practice of slavery in the Americas. Unfortunately, she died in 1504, leaving leadership to persons more susceptible to the influence of the Venice which remained the world's leading slave-trading nation, until the trade was taken over by the Dutch and British India companies. For Isabella, as for Cusa and his circle in Italy, the purpose of the voyages to the Indies was to evangelize, to win ecumenical allies against the enemy forces, against the tradition of oligarchical Babylon represented then by Venice and Venice's sometime partner, the Osman dynasty, which had taken over the Byzantine Empire. Ethiopia and India were among the projected allies of European civilization against the continued threat from the tradition of Babylonian oligarchical culture.
21. On the relevance of Gauss's and Riemann's collaborator Wilhelm Weber, see the contributions by Jonathan Tennenbaum and Laurence Hecht in *21st Century*, Fall 1996.
22. Lyndon H. LaRouche, Jr., "Leibniz from Riemann's Standpoint," *Fidelio*, Fall 1996. (G.F.) Bernhard Riemann, *Ueber die Hypothesen, welche der Geometrie zu Grunde liegen* ("On The Hypotheses Which Underlie Geometry"), *Bernard Riemann's Gesammelte Mathematische Werke*, H. Weber, ed., reprint of Stuttgart: B.G. Teubner, 1892 (New York: Dover Publications, 1953) [also (Vaduz, Liechtenstein: Saendig Reprint Verlag)], pp. 272-287.
23. *Ibid.*

Cusa's prescription for experimental physics: *measurement*.[24]

The scientific method which must underlie all successful science-driver programs, such as space-exploration, is that of experimental physics, rather than formal mathematical physics. The practical essence of the matter, that which predetermines the relative economic success, or failure of the program, is a breaking of frontiers, repeatedly, forcing paradoxes to manifest themselves, and discovering and validating the new principles of experimental physics needed to overturn, repeatedly, any pre-existing mathematical physics. The relative "not entropy" to be gained from a science-driver program, is to be associated with the advantageous changes in the physical space-time curvature of the manifold represented by human technological practice. It is the forcing of revolutionary discoveries in the domain of experimental physics, by successively, and successfully assaulting the seemingly impossible, which generates the success of (in this case) the space program, and also the gain in productive powers of labor derived as spillover from the science-driver program.

"It is from the characteristically 'not entropic' creative processes of individual human cognition, and from no other cause or source, that 'free energy' (for example, true 'profit') is generated within an economic process."

It is from such revolutionary discoveries of seemingly impossible new principles, that the creative powers of the human mind are called most fully into play. It is from the characteristically "not entropic" creative processes of individual human cognition, and from no other cause or source, that "free energy" (for example, true "profit") is generated within an economic process. If this were not so, the demographic characteristics of the human population would have been characterized, throughout all pre-history and history, by a secular shortening of life-expectancy, and a corresponding, "entropic," lowering of the potential relative population-density of every culture.[25] Therefore, for economic science, those who prefer to "play it safe," and urge us all to avoid technological progress, are rightly classed as social parasites, and, also, of course, heathenish opponents of *Genesis* 1:26-30.

Sail on, Columbus!

Why Choose Space-Exploration?

When we wish to be understood, in discussing modern, science-driver "crash programs," it is mandatory that we make mental reference to a number of clinical examples. Included among available choices, would be: Filippo Brunelleschi's application of the catenary principle, to effect the feasible completion of the cupola for the Florence cathedral of Santa Maria del Fiore; the work of Leonardo da Vinci; the A.D. 1461-1483 transformation of France into the first modern nation-state and national economy, under Louix XI; the science-driver development program of France's Minister Jean-Baptiste Colbert; the work of Lazare Carnot, Gaspard Monge, and their associates, both during the military crash-program of 1792-1794 and by the 1794-1814 Ecole Polytechnique under Monge;[26] the wartime U.S. mobilizations under Presidents Abraham Lincoln and Franklin Delano Roosevelt; the Manhattan Project; and, the German-American U.S. Space Programs of the early 1950s and the 1960s. There are other examples, but the list given suffices for our purposes here.

24. For example, *De docta ignorantia*. Thus, it is a delusion to think that "statistics are science," or that extrapolating a "model" within the virtual reality of a digital computer system, is "doing science." A related delusion of the mathematical formalists, is today's generally accepted, but absurd assumption, partly the fault of Hermann Grassmann, of "linearization in the very small."
25. For example, it was the proto-Malthusian, "zero-technological growth" feature axiomatically underlying the Code of Diocletian, echoing the Babylonian model of oligarchism, which imposed upon Byzantium its subsequent, characteristic demographic and moral degeneration.
26. Until the 1815 takeover and gutting of the Ecole by the Marquis Laplace and his protégé, the plagiarist Augustin Cauchy.
27. Clausewitz's works on warfare were published posthumously: originally, in a 10-volume edition (Berlin: 1832-1837). The most relevant edition is the *Vom Krieg*, published with an introduction by Alfred (Graf) von Schlieffen (Berlin: 1905).
28. Alfred (Graf) von Schlieffen, *Cannae* (Berlin: 1905), passim. Dino di Paoli, "Carnot's grand strategy for political victory," *EIR*, Sept. 20, 1996, pp. 14-29.
29. The point made here on the Schlieffen Plan, is of such prime relevance, that we could not fairly detour around the implied controversy. Lest some credulous reader have been duped by sundry British, French, Russian, and Woodrow Wilson administration liars, on the subject of the cause of World War I, the following facts should be listed. World War I was caused by no other agency than the British monarchy, specifically Albert Edward, as Prince of Wales, and as King Edward VII. In the eyes of the British Prince and his "Club of the Isles" cronies and lackeys, the *casus belli* of the matter was a strategy for destroying the British Empire, devised by U.S. President Abraham Lincoln. Lincoln's war-plan, which he would have executed, had the British not arranged Lincoln's assassination by its agent Booth, had three features: (1) The U.S. occupation of Canada, from which London had deployed its forces in the 1776-1783 War of U.S. Independence, the 1812-1815 war, and the Civil War of the United States against the treasonous British agents who had created Britain's slave-owner ally, the Confederate States of America. (2) The execution of Ericsson's design for a U.S. fleet of ocean-going Monitors, to blockade the British ports, and bring London to its knees. (3) As proposed by Henry Carey during the late 1860s, the creation of a system of transcontinental railways across Eurasia, from the Atlantic coast of a post-Napoleon III France, to the Pacific and Indian oceans.

    It must be remembered, that during the period from the outbreak of the U.S. Civil War, until the 1901 assassination of U.S. President William McKinley, the Russia of Czar Alexander II, of Dmitri Mendeleyev, and Minister Count Sergei Witte, was the leading ally of the United States against the U.S.'s deadly foes, both the British Empire and Napoleon III's France. Also most notable, are the alliance between the so-called "Lazzaroni" and other circles of Benjamin Franklin's great-grandson, Alexander Dallas Bache, and the circles of Gauss, Humboldt, Siemens, and Emil Rathenau, in Germany. The British monarchy chose to see the cooperation among France, Germany, and Russia, around the transcontinental railway projects as a *casus belli:* The plan to unleash a war in Europe which would permanently destroy such cooperation, was named the British "geopolitics" of the Prince of Wales, Halford Mackinder, Milner, et al.

    The Prince of Wales/Edward VII revived the former alliance with London's puppet, Napoleon III's France, over the period 1898-1904, as the so-called *Entente Cordiale*. Through the Russian Revolution of 1905-1907, Witte's influence was ruined, and Russia's Pan-Slav factions lured into the anti-Germany alliance with Edward VII's *Entente Cordiale*. It was Russia's late-July 1914 general mobilization for military assault on Germany, which pushed a peace-seeking Germany to declare war on August 1, 1914: moving to crush the French and British forces in the west, before bracing to meet the main body of Russia's military aggression from the East. Had Chief of the German General Staff, Helmuth von Moltke, not altered the Schlieffen Plan, Germany would have crushed France and the British Expeditionary Force in the initial flanking assault, Russia would have had no option but to make peace, and neither the prolonged World War I, nor World War II would have happened.

    In short, the doctrine of "exclusive German war-guilt" concocted by Woodrow Wilson's Secretary of State, Robert Lansing, is a fraud, from beginning to end. Schlieffen's morally untainted grasp of the principle must not be overlooked in the attempt to identify the principles for design of successful science-driver programs.

In each of these cases, a local (for example, Florence), regional, or national economy was mobilized, *as if to win a war,* around some set of tasks whose mastery required the mustering of what the great Gerhard Scharnhorst's protégé, Carl von Clausewitz, identified, in his *Vom Krieg* [On War],[27] by his use of the German term *Entschlossenheit:* To force successive breakthroughs in the form of valid discovery of new physical principles. The military language is appropriate, almost indispensable. The military-historical allusion is to the principle of the flank, as practiced with exemplary brilliance and success, during 1792-1794, by France's "Author of Victory," Lazare Carnot, and by Alexander the Great (Gaugamela), Hannibal (Cannae), and General William Tecumseh Sherman, the "Hammer" of General Ulysses Grant's "Anvil."[28] The "principle of the flank," as exemplified famously by Alexander the Great, Hannibal at Cannae, as set forth by the soldier-scientist Carnot, executed with consummate brilliance by Sherman, and built into Schlieffen's famous design for crushing the anticipated, two-front aggression by Britain, France, Russia,[29] corresponds precisely to the state of mind required for a successful science-driver program, or the discovery of a Christopher Columbus.

(index 1967=1.000)	1967	1973	1979	1982	1990
CONSUMERS' MARKET BASKET					
Men's trousers	1.000	0.965	0.594	0.504	0.335
Men's shirts	1.000	0.644	0.486	0.343	0.165
Women's blouses	1.000	1.023	1.511	1.405	0.684
Women's dresses	1.000	0.597	0.503	0.339	0.279
Women's woollens	1.000	0.264	0.254	0.139	0.166
Refrigerators	1.000	1.247	0.935	0.703	0.932
Passenger cars	1.000	1.150	0.869	0.484	0.512
Tires	1.000	1.020	0.833	0.666	0.877
Radios	1.000	0.706	0.467	0.316	0.098
PRODUCERS' MARKET BASKET					
Metal-cutting machine tools	1.000	0.643	0.530	0.289	0.212
Metal-forming machine tools	1.000	0.854	0.730	0.404	0.406
Bulldozers	1.000	1.200	0.713	0.334	0.306
Graders and levellers	1.000	0.786	0.748	0.383	0.349
Pumps	1.000	1.140	0.541	0.424	0.506
Steel	1.000	1.029	0.821	0.416	0.487
INTERMEDIATE GOODS FOR EITHER MARKET BASKET					
Gravel and crushed stone	1.000	1.023	0.914	0.624	0.575
Clay	1.000	1.022	0.759	0.459	0.544
Bricks	1.000	0.999	0.850	0.451	0.598
Cement	1.000	1.045	0.911	0.632	0.689

Figure 2
DECLINE IN PRODUCTION LEVELS FOR GOODS IN PRODUCERS' AND CONSUMERS' MARKET BASKETS ON A PER-HOUSEHOLD BASIS
In the United States, the production of physical market baskets has declined to about half of what it was in 1967. Today, the average working family must hold down three jobs to buy what a single job afforded in the 1950s and 1960s.

Source: *Executive Intelligence Review*, Sept. 27, 1996, p. 22

A weaker force may, sometimes, annihilate a more powerful one, by concentrating sudden and relentless waves of attacks upon a well-selected, predetermined "flank" of the opposing, superior force. The selection of such a point, or coordinated points of focussed attacks, requires the same qualities of intellect which must be summoned for driving through an apparent paradox to the validated discovery of a new physical principle. Scientist Carnot's dispatched commands to the various parts of the French military under him, during 1792-1794, illustrate the connection; the making and execution of such strokes, whether in warfare, or in science, may appear to subordinates as a terrifying spectacle of sheer, remorseless will by their commander. Once the commitment is made, one must not flinch, nor permit subordinates to waver. Whether in military command, or science, this is the meaning of Clausewitz's use of the term *Entschlossenheit* in *Vom Krieg.*

No soldier, or other professional, should wish ever to serve in combat under a commander who lacked this quality, nor face a crisis under a scientific or political leader who lacked the same quality.

Once that qualifying requirement is adopted for a science-driver enterprise, the question may be posed: *Among all the choices of science-driver programs which might be devised, why choose space-exploration?*

For our mission here, we must view science, not from the ivory-tower vantage-point of today's generally accepted classroom standpoint of formal mathematical physics, but, rather, from the standpoint of experimental physics, as this distinction, already stressed by the founder of modern science, Nicholas of Cusa, was emphasized in a new, and most profound discovery, by Bernhard Riemann.[30]

30. *Op. cit.* Riemann emphasizes this near the outset of his 1854 habilitation dissertation, and restates the point, summarily, in his close. For reason of the extreme relevance of the points to be developed, immediately hereinafter, we excerpt these references at some modest length. From pp. 272-273: . . . *Es wird daraus hervorgehen, dass eine mehrfach ausgedehnte Grösse verschiedener Massverhältnisse fähig ist und der Raum also nur einen besonderen Fall einer dreifach ausgedehnten Grösse bildet. Hiervon aber ist eine nothwendige Folge, dass die Sätze der Geometrie sich nicht aus allgemeinen Grössenbegriffen ableiten lassen, sondern dass diejenigen Eigenschaften, durch welche sich der Raum von anderen denkbaren dreifach ausgedehnten Grössen unterscheidet, nur aus der Erfahrung entnommen werden können. . . . Diese Thatsachen sind wie alle Thatsachen nicht nothwendig, sondern nur von empirische Gewissheit, sie sind Hypothesen; man kann also ihre Wahrscheinlichkeit, welche innerhalb der Grenzen der Beobachtung allerdings sehr gross ist, untersuchen und hienach ueber die Zulässigkeit ihrer Ausdehnung jenseits der Grenzen der Beobachtung, sowohl nach der Seite des Unmessbargrossen, als nach der Seite des Unmessbarkleinen urtheilen.* Riemann returns our attention to this crucial portion of his opening argument, in the closing sentence of this dissertation (p. 286): *Es führt dies hinüber in das Gebiet einer andern Wissenschaft, in das Gebiet der Physik, welches wohl die Natur der heutigen Veranlassung nicht zu betreten erlaubt.*

"'Human knowledge' must be understood to signify nothing other than validation of man's discovery of those principles of change, by means of which man can, or cannot, cause the universe to bend to man's will."

Stuart Lewis

Children constructing a sundial in a class on solar astronomy.

Look, then, at experimental physics. Look at it from the standpoint we have outlined up to this point. Bear in mind our reference to Riemann's devastating proof against a mathematical-formalist approach to mathematical physics. Bear in mind, that the present writer and Riemann base themselves upon the scientific method inhering in Plato's method of hypothesis. Bear in mind the approach to Leibniz's specification for a "hyper-mathematical" method of Analysis Situs, as this writer has presented the case for the science of physical economy.[31] Under those explicit and implied conditions, the "map" of human knowledge (science), is constructed as follows.

1. *"Human knowledge," or "knowledge,"[32] must be understood to signify nothing other than validation of man's discovery of those principles of change, by means of which man can, or cannot, cause the universe to bend to man's will.* The conception of objects as fixed objects per se, is not knowledge; only the validated principles of change affecting designated objects, permits one to speak truthfully of "knowledge of" an object.
2. *"Knowledge" can be acquired by no other means than metaphor. "Metaphor" references the existence of that quality of paradox, in which an undeniable event mocks stubbornly an implicitly referenced system of belief. The only solution to such a paradox, is the generation of an appropriate new system of belief by means of the sovereign cognitive processes of the individual's mind. The experimental, or equivalent validation of that generated new conception, establishes that conception as enjoying the authority of a physical principle. The reconstruction of the old system of belief in a way which coheres with the validation of the newly discovered principle, constitutes "knowledge," then so acquired, and enjoyed, by that individual's mind.*[33]
3. *The authority of such "knowledge," is located, ultimately, in the demonstration of the efficiency of the new system of belief, respecting a society's, or mankind's ability to command the universe to such effect that the characteristic*[34] *productivity, potential relative population-density, and other demographic features of the human species' existence, are improved.*
4. *Such knowledge, as qualified by the "Great Experiment" of advancement in the characteristics of the existence of the human species within the universe at large, constitutes knowledge of what is termed "Natural Law."* Other names for "Natural Law" are "Reason" (as used by Johannes Kepler, for example) and "necessary and sufficient reason" (G. Leibniz).
5. The principles of knowledge are equally efficient for, and equally represented by physical science and the production of masterworks in Classical forms of art.[35]

With these definitions and implications in view, one may then proceed to construct a cohering map of the knowledge to be derived from the directed progress of experimental physics. This map defines the terrain on which science-driver forces deploy their relevant flanking operations. Retrace the steps which this writer followed in his initial, 1985-1986 design of a 40-year development for the initial colonization of Mars.

Already, in the "Plan of the Investigation," at the beginning of his 1854 habilitation dissertation, Riemann defined the entire domain of experimental physics as divided among three, mutually distinct sub-domains. In contemporary English-

31. On the role of Analysis Situs in physical economy, see Lyndon H. LaRouche, Jr., "While Monetarism Dies," *EIR*, Oct. 25, 1996.
32. Of all known species subsumed by eternity, only the human species is capable of knowledge. Hence, the strictly admissible use of "knowledge" to signify "human knowledge."
33. The resulting knowledge occurs in the form of a new hypothesis, as Riemann describes this for physics. This use of Plato's principle of hypothesis, is the common foundation of all of the scientific work of both the present writer and Riemann.
34. "Characteristic" in the sense of "curvature" of a specific physical-space-time manifold.
35. See Lyndon H. LaRouche, Jr., "The Essential Role of 'Time-reversal' in Mathematical Economics," *EIR*, Oct. 11, 1996.

language usage, these are: (A) *Astrophysics,* (B) *Microphysics,* and, the residue of the evidence, relations whose effects may be observed directly within the domain of the senses, (C) *Macrophysics.* In each of these domains, we are presented with three distinct species of phenomena: (1) Ostensibly non-living processes, including so-called "organic" ones; (2) Living processes, which are ostensibly not capable of cognition (all species below the level of man); and, (3) The cognitive processes we have repeatedly referenced here. Thus, all science is represented by the transitions associated, in experimental practice, with all existing permutations of combinations from among nine cells defined by three rows and three columns.

However, all of the knowledge we are able to acquire by these means, belongs to the domain of cognition. It is our cognition of the "Great Experiment," human development itself, which subsumes the knowledge we possess of each cell, and of the relations associated with all actual transitions corresponding to possible permutations of combinations from among the nine cells. All of our presumed knowledge of the lawful design of our universe is limited to the knowledge we acquire from the vantage-point of no other means than the *cognition* of the "Great Experiment."

At the highest level of physical science, scientific knowledge is none among its subsumed specialties; at that superior level, where the name of "science" properly reposes, it is the discernible transitions which link each and all among the cells, not the internal features of any one cell, which represent the ingredients of scientific knowledge. It is the transition which subsumes and thus unifies those many transitions, which supply the word "science" a specific ontological content.

Yet, any persisting paradox within any part of that unfolding tableau, challenges any hypothesis associated with scientific knowledge in general: whether the challenge arises from biological microphysics, as an astrophysical anomaly, or any other permutation assembled from among the nine cells.

Among all sources of such paradoxes, a handful of questions are crucial for science as a whole. What is the transition which, in an instant of dying, represents the transition from the generative characteristic distinction of a living process, to that of all non-living ones? What is the transition from a merely living process, to the control of the actions of a living process by a process of cognition? How were the planets of our Solar System, with their chemical composition, and other distinctions, generated by the shedding of rotation from our much-younger, faster-rotating Sun? What are the principles by which our astrophysical universe continues to be generated? How are the transitions of the astrophysical domain to be reconciled, functionally, with the characteristic microphysical distinctions among non-living, living, and cognitive processes?

The central question is: What are the experimentally demonstrated absurdities of our presently established systems of established scientific belief, in each niche of our map of permutations, especially the most notable niches? What additional absurdities of this type might we succeed in evoking? Instead of taking on these issues, one at a time, why not organize a coordinated project, in which we attack several among the most crucial such paradoxical flanks, as a single, integrated campaign? That is the standpoint which defines the distinction between ordinary scientific research, and a science-driver approach of the type illustrated by the Manhattan Project or a space-exploration program.

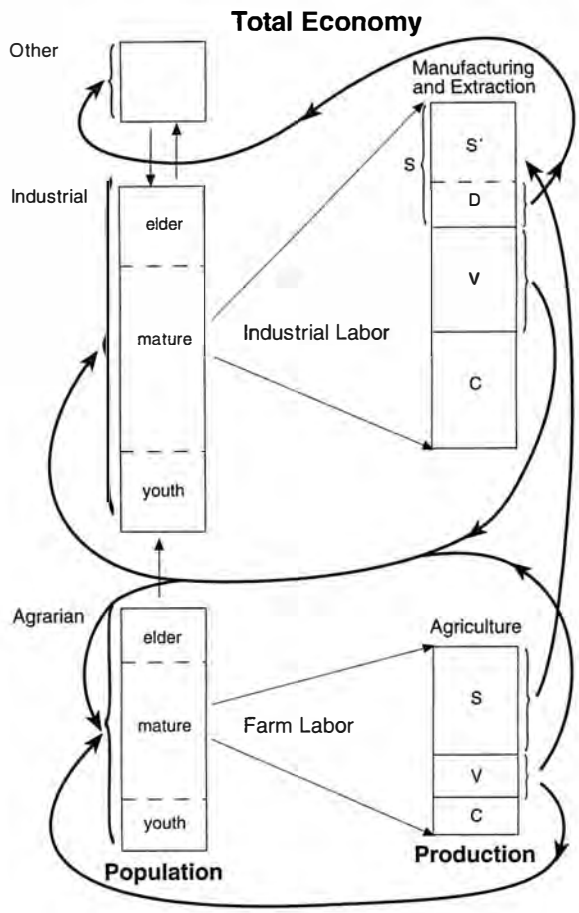


Figure 3

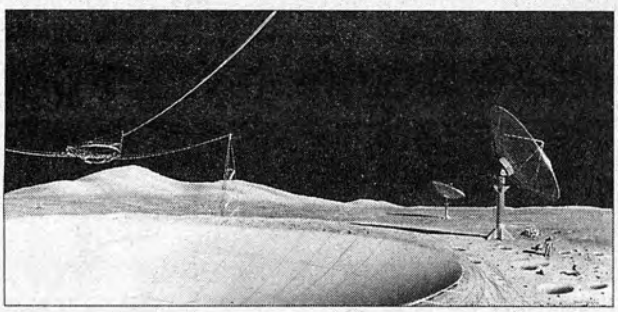
THE RATIO OF THE ECONOMY'S 'FREE ENERGY' TO ITS 'ENERGY OF THE SYSTEM' MUST NOT DECLINE

The economist's goal, is to ensure that the ratio of "free energy" to "energy of the system" does not decline, even though the "energy of the system," per capita, is being increased. In this diagram of the physical-economic process, the vertical bars represent 100 percent of population (left) and of production (right). Free energy is represented by S'. C represents capital goods consumed by the production process, including the physical infrastructure of physical-goods production. V represents the portion of total physical-goods output required by all households from which industrial and agricultural labor comes. S is gross operating profit of the entire agro-industrial process of the economy, from which D, total overhead expense, must be deducted.

Source: Lyndon H. LaRouche, Jr., 1995. "Non-Newtonian Mathematics for Economists," *Fidelio,* Vol. 4, No. 4 (Winter), pp. 4, 14

Since the most fruitful form of science-driver project available, is one which includes microphysics under a regime of astrophysical revolutions, one which involves a living, cognitive process—man—exploring the astrophysical domain, the most profitable of all science-driver projects, is a long-term, manned

"By working in space, and on Earth, simultaneously, for these coordinated breakthroughs in discovery of new principles of astrophysics, microphysics, and biology, by the time . . . we establish the first science-city colony on Mars, we shall have revolutionized science and economy on Earth, each many times over."



NASA

An artist's depiction of a lunar observatory on the far side of the Moon, where a large radio telescope is mounted in an existing crater. The telescope dish focusses signals into a centrally located collector suspended above the crater. The lander, in which the crew lives, is in the distance on the left. Two steerable radio telescopes are on the right. A long-baseline optical interferometer system is in the right far background.

space-exploration program.

For example: Merely taking human beings off the surface of Earth, and putting them into the stratosphere, and higher, begins the process of driving the capabilities of the human being, as a living, and as a cognitive process, to its limits of adaptability and performance. A round-trip journey from geostationary Earth-orbit to the Moon, and back, could become almost a mere weekend jaunt, when compared with the stresses of flight to Mars-orbit: for example, continuously powered flight, is necessary —"a whole new kettle of fish."

Why send man to Mars at all? There are several absolutely irrefutable objections to any argument that man ought not be preparing to colonize Mars right now.

The first objection, is the well-known apothegm: "It is there." History shows us, that whatever it might be nearly impossible to achieve, is precisely what mankind must commit itself to achieving, if the human species is to survive. Often, we have discovered why it was imperative that we attempt the seemingly near-impossible, only after we have achieved it.

The second objection might remind us of the recent proposal, that computer management might control the medical judgments of physicians, or that nurses might be replaced by "technicians" whose training, from welfare rolls to hospital assignments, might be accomplished with a few weeks' training in simple routines. No linearized device, or training, can substitute for the cognitive powers of the individual mind of a professional. The computer that controls the physician's decisions on care, will be guilty of malpractice much of the time, perhaps most of the time, often fatally. The replacement of nurses by unskilled "technicians," also means an assured increase in morbidity rates in hospitals. The same is true in all scientific work. The tool is no replacement for human cognitive powers, never more than a useful aid to irreplaceable, human cognition by the trained professional.

The "Christopher Columbus Principle of Physical Economy," properly governs competence in both voyages of discovery, of all kinds, and in the functions of irreplaceable human cognitive powers of professionally trained judgment.

To set up space-laboratories which can probe a far fuller spectrum, than is possible from near-Earth orbit, and with far greater resolving power, we must go as far from our noisy Sun as possible. Men must go into solar orbits far from any planet, to construct "radiotelescopes" of enormous aperture, to focus upon all of the most anomalous astrophysical objects. There must be space laboratories similarly constructed and situated. This requires a "science city" built up, as far from Earth as is practicable. Given the inherent limitations of future thermonuclear fusion, pending "fuels" of superior power-to-mass ratios, Mars is the available, usable object within reach, on which to construct a "science city" colony under an artificial environment: a kind of "Los Alamos in Space," ultimately capable of supporting about a quarter-million or more scientists and support personnel.

The general mission assignment, is to drive astrophysics, microphysics, biological science, and human knowledge, to far beyond their presently forseeable limits for the coming century. By working in space, and on Earth, simultaneously, for these coordinated breakthroughs in discovery of new principles of astrophysics, microphysics, and biology, by the time, approximately 40 years hence, we establish the first science-city colony on Mars, we shall have revolutionized science and economy on Earth, each many times over.

The Tavistock Papers

During the middle of the 1960s, a representative of the British Imperial psychological-warfare agency, the London Tavistock Centre,[36] conducted a study of the psychological effects of President Kennedy's *Apollo* program upon the U.S. population. The mid-1960s Tavistock report complained, that the U.S. space program was inspiring an excess of rationality and optimism within the U.S. population, and argued, successfully, that, for this reason, the space-program must be cut back sharply. The following year, the U.S. government collapsed the Apollo program, to the degree that the initial manned Moon landing could be completed on schedule, but little more after that. For this, and also other reasons, the rationality and optimism of the U.S. population has subsequently withered to a

36. The origins and character of the London Tavistock Centre, was the subject of an intensive, task-force study, done under the present writer's direction, during the early through middle 1970s. The first reports, under the title of "The Tavistock Grin," occupied two successive editions of the *Campaigner* monthly, April and May, 1974. The present Tavistock Centre, the London Tavistock Clinic, was established under the direction of the head of the British psychological-warfare program, one Brigadier Dr. John Rawlings Rees, the man who supervised the brainwashing, in captivity, of Nazi Deputy *Fuehrer* and Tibetan mystic, Rudolf Hess. Later, the Clinic was enveloped by the larger institution built up around it, the Tavistock Centre where the British foreign intelligence trained its subsequently self-avowed agent of influence, Henry A. Kissinger.

"The mid-1960s Tavistock report complained, that the U.S. space program was inspiring an excess of rationality and optimism within the U.S. population, and argued, successfully, that, for this reason the space-program must be cut back sharply."

President Kennedy addresses a crowd of 35,000 at Rice University in Houston, during his tour of U.S. space installations.

degree which the Tavistock Centre must consider gratifying.

Those who can still remember the United States of 30 years or so ago, could supply the wistful observation, that the general availability of skilled employment, by aid of which we might once again have entire communities in which single-income-earner families raise children under normal conditions, does tend to foster a degree of happiness which is virtually lacking in 80 percent or more of our population today. The writer and most readers might agree, that if a population enjoys a standard of community and family life consonant with the argument which Leibniz made in his 1671 *Society & Economy,* this would mean a society less violent, less perverse, less fearful, less hate-brimming, and much less unhappy, than is characteristic of most of our population today. A science-driver program which targetted the establishment of a science-city colony on Mars, beginning about 40 years hence, would enable us to meet those standards of community and family life once again. That means less unhappiness, but it does not assure happiness; the moral benefit of a science-driver Mars program comes from a different quarter than the undeniably considerable material benefits such a program would generate.

Man is not a beast, unless he chooses to degrade himself into beastliness. Man and woman are creatures which *Genesis* prescribes to be "made in the image of God," to rule the universe accordingly. The experimental evidence supplied to our powers of Reason confirms *Genesis* on this account. Such, not the beastly creature of Thomas Hobbes and John Locke's rants, is the true nature of men and women. We are essentially creatures of ideas, of knowledge. When our minds are employed in the manner our true nature prescribes, and we are acting according to those principles of Reason, we are capable of great contentment in the simple fact of being our true selves. When we men and women discover our true nature, and act accordingly, we act with great passion, but also a serene contentment, the contentment of certainty that we are living lives of a quality which triumphs over death.

Yet, when we follow Hobbes, Locke, Mandeville, Hume, Bentham, and Mill, we are never happy. For us, then, jaded pleasures guide us to expanding frontiers of perversity, like Oscar Wilde's fabled Dorian Grey. There is no happiness, no contentment, but only momentary excitements, each banging and flashing like fireworks, before the old boredom returns, more insatiable than before.

The happiness which was deplored by the referenced Tavistock report on the Apollo program's effects, can be traced to a joyful sense of participation in a society which the future must admire. It is sense of living in a world brightened each morning by beautiful, and also powerful ideas. It is a society, in which a child, asked, "What are you going to be when you grow up," responds with eyes filled with the happiness of a big little person's optimism.

The material benefits great programs afford, are necessary; but, it is the beauty of discovering those ideas which make such programs possible, which is the true inspiration of entire peoples. Sail on, Columbus! Discover, once again, the secret of being human for those you leave behind.

Economist Lyndon H. LaRouche, Jr., is a member of the scientific advisory board of 21st Century *magazine.*

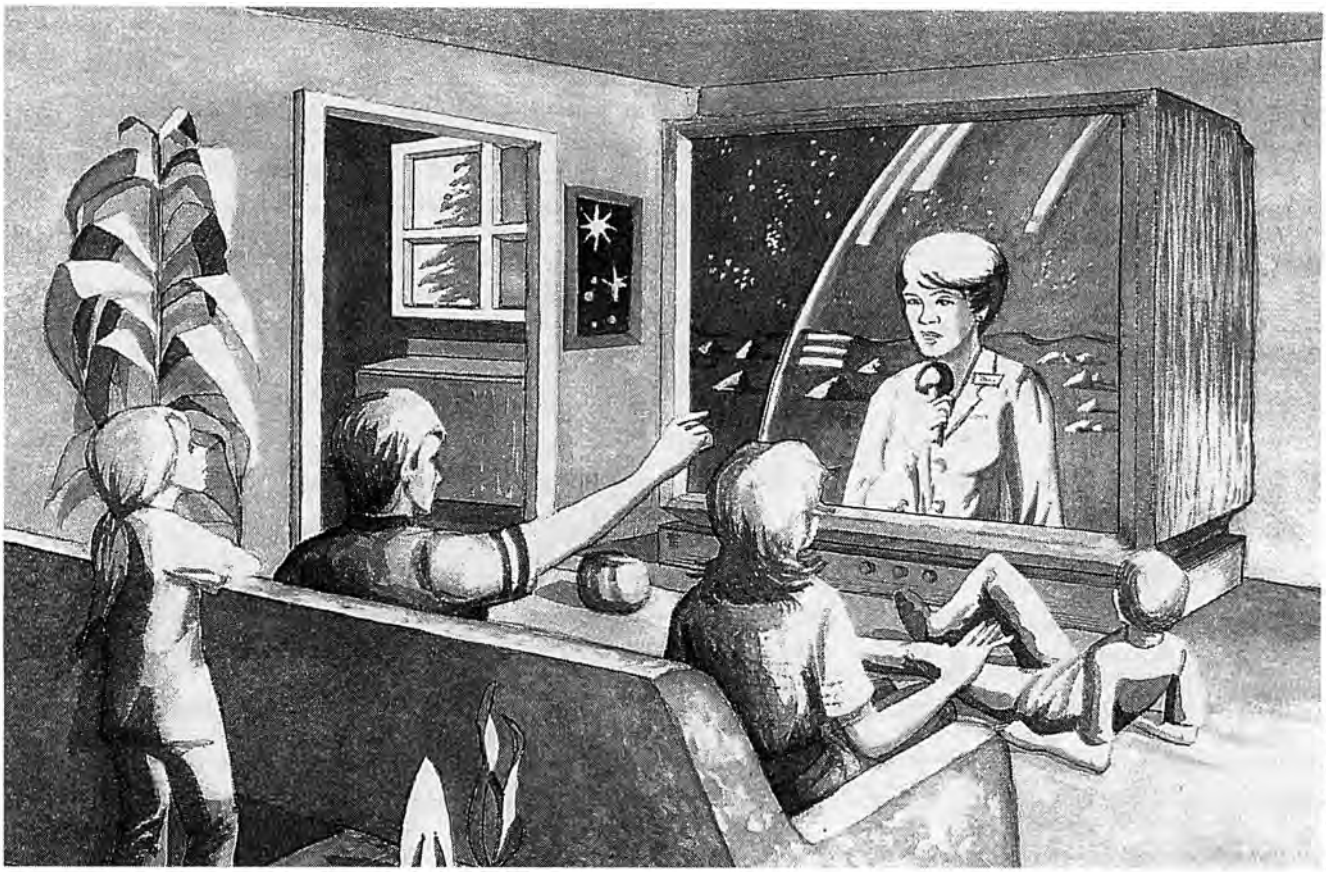


Illustration by Brenda Brown

The Woman on Mars

by Lyndon H. LaRouche, Jr.

How a 40-year mission to colonize Mars would transform the United States.

Introduction

What I am about to present to you are the highlights of present U.S. plans for establishing a permanent colony on Mars by approximately the year 2027 A.D. The plans to be outlined here are based on the two somewhat similar, but slightly differing versions of the plan as developed by various U.S. specialists. One plan is that first presented at a June 1985 conference in honor of the space pioneer, Krafft Ehricke, who died at the end of 1984. The second plan, is one drafted by the National Commission on Space, and presented approximately a year after the Krafft Ehricke conference. This presentation will emphasize the approach laid out at the Krafft Ehricke memorial conference, but it will also make use of important features of the proposals by the Commission on Space.

For this purpose, I ask you to come with me, in your imagination, to a Wednesday in September, in the year 2036 A.D., nine years after the Mars colony has been founded. Starting from an imaginary television broadcast to Earth at 1800 hours London time, that day, let us look from that day and year, back

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Lyndon H. LaRouche, Jr., an economist, wrote this as a draft script for a motion picture or slide-show in January 1987. An abbreviated version was the basis for a half-hour television broadcast, as part of his 1988 campaign for the Democratic Party's Presidential nomination.

The NASA illustrations used represent a variety of designs under discussion over the last 30 years.

◀*Everyone tuned in to the science update broadcast live from Mars.*

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to the time of the United States' adoption of the Mars colonization project, and trace each major step of the project from the year 1989, up to the year 2027, the year the first permanent colony on Mars is finally established.

Those who have worked to prepare this presentation, have thought that we must use our powers of imagination in this way. It is thought, that we must focus attention on our destination as we outline each step of a journey. It seems to us, that that is the only way this project, and its importance for all mankind, can be properly understood.

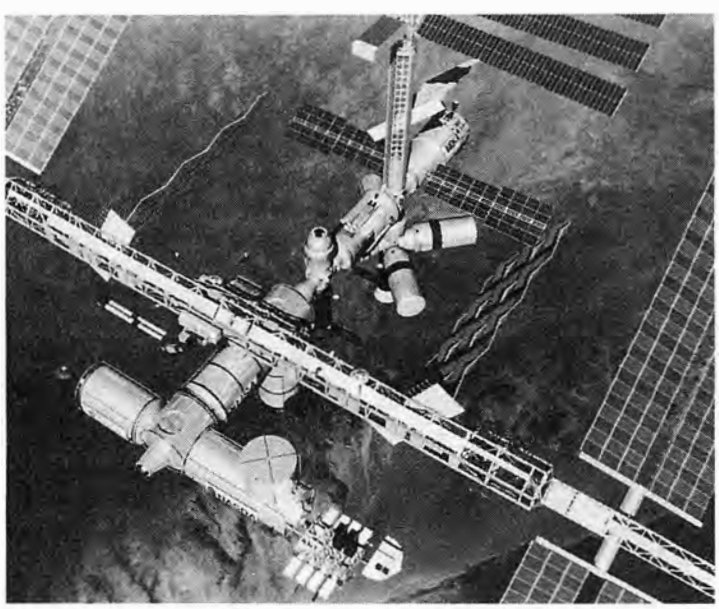
To present the project in this way, it is necessary to include some imaginary political figures and political events, so that we might present this as a story. However, the technical facts we use here represent the scientific and related facts of the Mars colonization plan as those facts exist today.

The BBC television studio's clock says that it is 1800 hours in London, on Wednesday, September 3, 2036 A.D. From 55 million miles away, on Mars, a televised image travels nearly 5 minutes across space, to be picked up by the giant geostationary receiver hovering over the South Atlantic, from where the signal is relayed to other satellites, reaching waiting disk-antennas around the world. A woman's face appears on the BBC screen.

The woman on the screen is in her late thirties. The sight of her familiar features brings expressions of admiration to the viewing audiences now receiving this live broadcast around most of the world. She is Dr. Ellen Jones, chief executive of the Mars colony, and the daughter of the famous space pioneer, Dr. Walter Jones, who headed the U.S.A.'s Mars-colonization program from 2008 until his retirement in 2027.

"I bring you greetings from your 683,648 relatives and friends living here on Mars, and some very good news," she begins. "Our astrophysicists agree, that with our latest series of observations at our Cyclops III radiotelescope, we have solved at least a good part of the mystery of what you know as black holes. We are convinced that we are at the verge of fundamentally new ideas about how our universe works."

The TV audience followed her 5-minute televised report with a scientific interest which would have been unimaginable when the Mars-colonization mission was first launched by the U.S., back in March 1989.



NASA

A low-Earth orbit International Space Station, composed of elements from the United States, Europe, Canada, Japan, and Russia.

The 1990s flights of transatmospheric craft up to stations in low-Earth orbit, had revived the spirit of the popularity of space-exploration from the Apollo-project period of the 1960s. After Earth's first geostationary space-terminal had been completed near the end of the 1990s, manned flights to the Moon had soon become routine. Over the 1990s, the point was reached that every schoolchild, not only in the U.S., Europe, and Japan, but throughout the world, demanded to know everything possible about space.

Beginning the 1990s, fewer and fewer university students attended courses in the social sciences, as the physical sciences, including space biology, took over the classrooms almost completely. Even at preschool ages, more and more children, asked what gift they wished for Christmas, would answer, "a telescope." As the industrialization of the Moon began near the end of the 21st century's first decade, to look up was to express optimism about the human race's future. Space and the spirit of adventure became one and the same.

There had been a deeper quality of changes in attitudes. What had been the most popular competitive sports of the 20th century became less popular, and achievement in swimming, track and field, and mountain-climbing, the most popular features of physical education programs. "Keeping in shape for space travel," was the value which more and more attached to physical education.

Twentieth-century man would be astonished to know the new way in which "spirit of adventure" was translated during the early decades of the 21st. Some things 20th-century man would have recognized. Being the first to set foot on some planetary body, was of course a commonplace fantasy among children and youth. The difference was, most teenagers, and some much younger, already knew the real purpose of space exploration. That purpose was, to acquire knowledge which the human race needed, and could not gain without scientific exploration of our universe in a way which could not be done without traveling far beyond Earth's orbit. The idea of adventure, was not a matter of simply getting to some strange place out there. Exciting adventure, was to participate in making some exciting new discovery in space, which would be useful to the majority of the human race remaining back here on Earth.

So, those children and youth gobbled up every bit of information they could, with the purpose being to understand what kind of knowledge mankind was seeking out there.

The last two years, 2025-2026, just before the building of

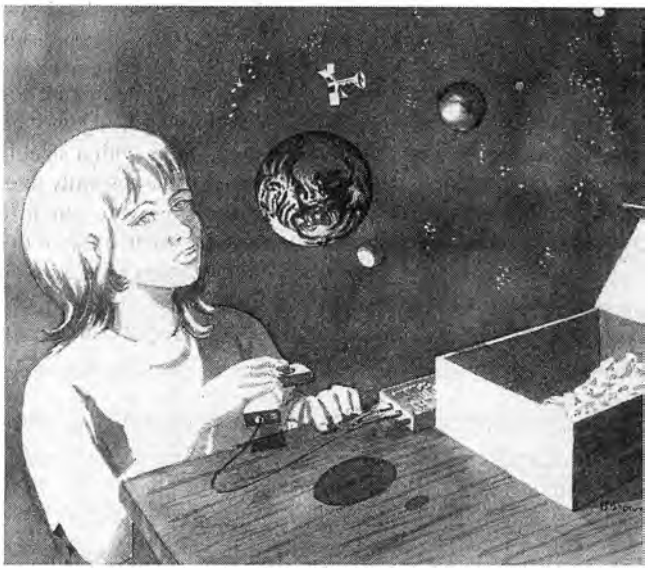


Illustration by Brenda Brown

Over the 1990s, every schoolchild demanded to know everything possible about space. Children tracked the positions of the space flotillas and reconstructed the spacecraft and Mars colony.

Bill Ingalls/NASA

Schoolchildren in Tampa, Fla. outfitted for a mission on their "Space Shuttle" bus, which is designed inside like a Shuttle orbiter.

the first permanent colony on Mars, had seen the most rapid transformation in popular values here on Earth.

The TV screens had been filled often with images of those giant spacecraft, each much larger than a 20th century ocean liner, taking off from the vicinity of Earth's geostationary space-terminal, in flotillas of five or more, each seeming to thunder silently in the near-vacuum under 1-gravity acceleration. By then, a permanent space-terminal was being constantly manned in Mars orbit. The televised broadcasts from that terminal showed the monstrous spacecraft arriving. Earth's television screens showed the gradual accumulation of that vast amount of material in Mars orbit, waiting for the day it would descend to Mars's surface. TV viewers on Earth saw the first craft, designed to descend and rise through the thin atmosphere of Mars, and saw views of the approaching Mars surface from the cockpit, through the eyes of the cameras.

A great anticipation built up throughout Earth's population during those last two preparatory years. Then, Earth went through what was afterward described as the "sleepless year," as the first city was assembled on Mars, during 2027. Audiences on Earth demanded to see every step of the construction relayed back here. Nearly everyone on Earth became thus a "sidewalk superintendent" for as many available hours as his or her sleep-starved eyes could be kept open. On waking, it was the same. The daily successes reported from Mars were discussed as widely and in as much detail as 20th century sports fans debated the details of a weekend's football play.

By then, holographic projections had become as economical and commonplace as personal computers had been during the 1980s. Building a synthetic holographic model of the solar system, and constructing a powered-flight trajectory, such as one between Earth and Mars, became quite literally child's play. A child's parent could purchase a packaged program at a local store, and the child often insisted that this be done. Turning on one's system, and updating the positions of the planets and the course of a space-flotilla flight in progress, became a habit with many. The same was done with various stages of the construction of the first permanent colony. Whatever was seen on the TV screen, was something one wished to reconstruct. The passive TV watching of the 20th century had come to an end.

The first large-aperture radiotelescopes had been constructed a million or so miles from Mars, as soon as the manned orbiting space-terminal had been completed. The system of observatories and space-laboratories associated with them, was expanded rapidly, once the first 100,000 permanent colonists had begun to settle in. Popular fascination here on Earth, shifted its focus somewhat from the Mars colony itself, to these new projects.

It was such a worldwide audience which sat or stood, absorbed with every sentence of Dr. Jones's 5-minute report, either as it was being broadcast, or when morning reached them a few hours later. Throughout the planet, over the course of that Wednesday and Thursday, there was the eerily joyful sense that humanity had reached a major milestone in the existence of our species. It would be said, in later decades, that on that day in 2036, the Age of Reason had truly begun.

At the beginning of the 1950s, space pioneers such as Wernher von Braun had begun working out the specifications for manned flights to Mars. One leading Peenemünde veteran,

NASA

An early manned Mars mission to collect samples.

Krafft Ehricke, had been certain that the U.S. could have sent a manned exploratory flight to Mars as early as the 1980s. Unfortunately, near the end of 1966, the United States had cut back massively on its aerospace programs. Presidents Johnson and Nixon did not eliminate President Kennedy's popular commitment to a manned landing on the Moon from the NASA program, but most of the other aerospace projects, such as nuclear-powered propulsion development, were cut back, and cut back savagely as soon as the program of initial Moon landings had been completed. Krafft Ehricke continued toward his completion of the design for industrialization of the Moon, but he died in 1984, his work nearly completed on paper, with no visible prospect that the U.S. would resume such a commitment during the foreseeable future.

It was not until shortly after Ehricke's death that a renewed U.S. commitment to colonization of Mars appeared. The proposal for a permanent colony on Mars as early as the middle 2020s, was a featured presentation at a Virginia conference held in honor of Krafft's memory, in June 1985. Nearly a year after that, the National Commission on Space adopted the same target date, and its proposal was endorsed, although without significant funding, by President Ronald Reagan. However, the Mars colonization project was a featured part of the January 1989 State of the Union address of the new President. During March of 1989 a U.S. Moon-Mars Colonization Commission was established. During that month, the Congress rushed through approval of treaty agreements which the President negotiated with Japan and Western European governments, establishing these allies as partners in the U.S.-sponsored Moon-Mars Colonization Project, following on similar international agreements which had led to the construction of the space stations of the 1990s.

Popular enthusiasm for the project was so great, that the President was able to secure a $5 billion initial budgetary allotment for the new project. Japan matched this with a sizably increased allotment to its own aerospace program shortly after that. Confident that changes in U.S. policies were going to bring the world out of what threatened to become a major depression, Western European governments came close, in total, to matching Japan's budgetary allotment.

The successive phases of the Moon-Mars colonization project were agreed upon that same year.

It was quickly understood, that planting a permanent colony on Mars is a far different sort of undertaking than sending a manned exploratory vessel to visit Mars. Leaders recognized, that to establish a colony of even a few hundred members of scientific parties on Mars would require a very large complex of production workers, agriculturalists, and so forth.

Back at the end of the 1980s, most citizens and politicians did not yet understand the significance of the fact that Mars is an average 55 million miles distance from Earth during the period one might ordinarily think of making such a flight. To sustain just a few hundreds persons there, required, by late 20th century standards, a tremendous number of ton-miles of freight to be shipped from Earth annually. The scientists understood this immediately, of course, but it required a lot of effort to make this clear to most of the politicians, and to popular opinion.

The scientists realized very soon, that we should plan to put not just hundreds of scientists, engineers, and technicians, on Mars. The purpose for going to Mars in the first place was scientific investigations. The main purpose was to build a system of enormous radio telescopes in the region of

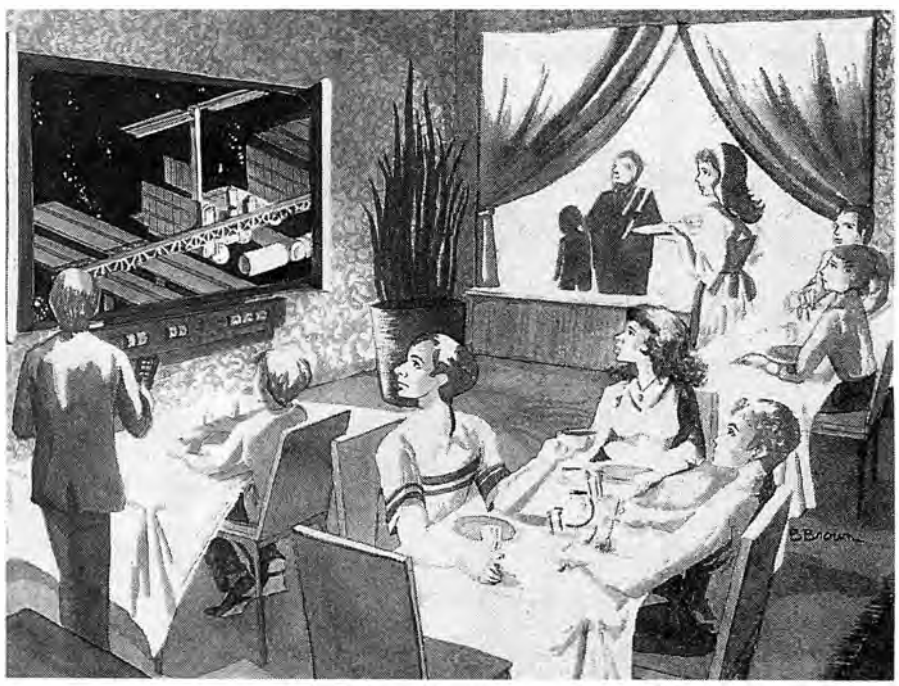
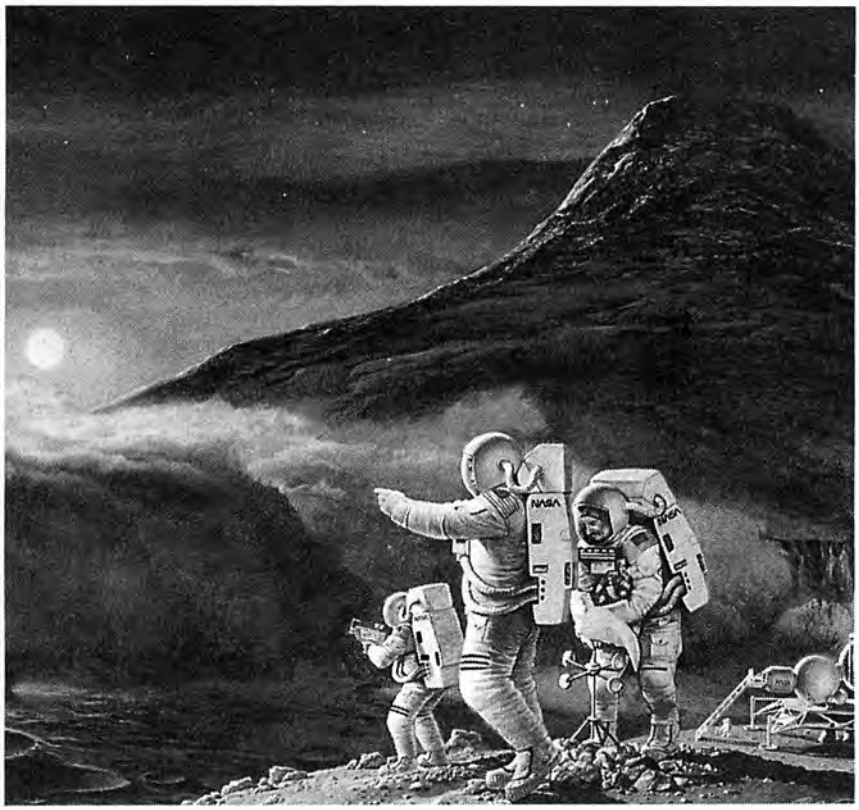


Illustration by Brenda Brown

In the "sleepless year," 2027, Earth audiences watched every step of the construction of the first Mars city.

space near Mars, and to conduct the construction, maintenance, and improvements of these observatories from bases both in Mars orbit and on the surface of the planet. Using U.S. experience in demonstration tests of trained human individuals' efficiency working in low-gravity Earth-orbit gained from the 1980s Space Shuttle and the 1990s space stations, it was estimated, that to construct as many observatories as Earth would need to explore the universe in as fine detail as must be done from Mars orbit, would require hundreds of thousands of man-hours each year. This figure included estimates on the number of days a year a human being could safely work in a very low-gravity field.



NASA

Astronauts are collecting Mars samples and conducting scientific observations, while a dust storm is approaching the cratered area near the landing site. In the background is Olympus Mons.

The scientists estimated, that the cost of keeping a research worker alive on Mars adds up to a total amount of equipment more than 10 times that required to sustain a scientist in the middle of the Sahara or Antarctica. This did not include the estimated costs of transporting all that tonnage from Earth to Mars. The scientists explained to the politicians, "Mars is a very cold place by Earth standards, with a very thin atmosphere, a shortage of known water-supplies, and a lower gravity than Earth. People living on Mars must live in man-made environments under protective domes. The costs of maintaining those domes, of maintaining water supplies, of maintaining the atmosphere, and maintaining an acceptable temperature within the artificial climate, are enormous by Earth standards." The biggest factor of cost those scientists had to consider was the cost of energy; they estimated that more than 10 times the amount of energy must be available, per person, on Mars, than the energy directly consumed by research teams in the Sahara or Antartica.

They decided that the basic source of energy used on Mars would have to be thermonuclear fusion, as it already was on the Moon. They pointed out, that the Mars colony would need very concentrated sources of industrial energy, to enable the

Philip Ulanowsky

Carlos de Hoyos

Children spent their time building models of everything to do with space—from spacecraft to fusion power plants.

colony to produce food and to sustain itself with the largest part of its requirements in materials.

So, it was agreed that the way to sustain our teams of research workers on Mars, was to build a local supporting economy on Mars. They estimated that between a quarter and a half million total population would be the minimum size for a successful colony. They thought that this might be sufficient, if we gave Mars the new generation of industrial technologies which were in the initial development stages on Earth back during the 1980s.

They saw, that to get that number of people to Mars, together with all that was needed to start up a colony of this size, was plainly impossible using the methods worked out for sending a manned exploratory flight to Mars. To lift that amount of weight from Earth's surface, up into high-Earth-orbit, by conventional rocket methods in use in the 1980s, was beyond possible limits of cost. Even if the cost were greatly reduced by improved methods of liftoff, the amount of weight which would have to be lifted to deliver the requirements of a quarter to half a million Mars colonists from Earth, was still so costly as to be out of the question.

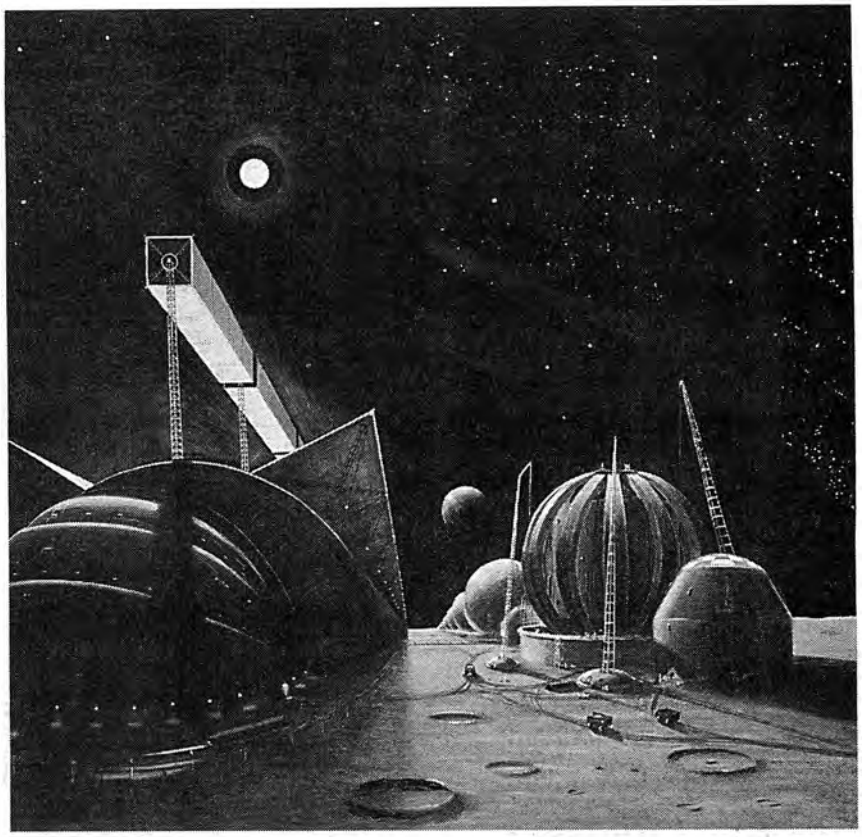


Illustration by Christopher Sloan

It was decided that only thermonuclear fusion could provide enough energy to economically power industry and maintain the necessary artificial climate for large colonies. Here, fusion tokamak plants are lined up on the Moon, as conceived by space scientist Krafft Ehricke. A lunar monorail transportation system can be seen above the lunar city that he named Selenopolis.

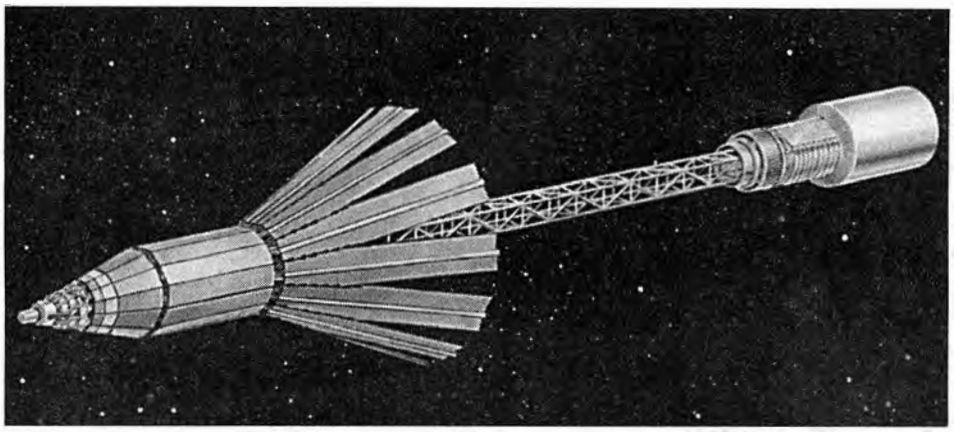
The politicians had imagined, wrongly, that starting a colony on Mars was like establishing a research base-station in the Antarctic. The politicians imagined, that the technologies developed for sending a manned team of explorers could be expanded to transport a much larger number of colonists. The scientists had to make clear why this idea was badly mistaken.

First of all, human bodies are designed to function under one Earth gravity, or at least something near to that. The human body might be able to adapt to gravities a large fraction of those on Earth, but long flights at nearly zero-gravity are very risky, and were thought to be quite possibly fatal. So, the idea of sending people to Mars in the way we sent astronauts to the Moon, was ruled out. The best way they knew to create the effect of one Earth gravity in spacecraft was to have that spacecraft constantly powered by one Earth gravity's worth of acceleration, or at least a large fraction of one Earth gravity, creating an effect very much like the way a person's weight increases when being accelerated upward in a 20th century elevator. The scientists pointed out, that powered flight at one-Earth-gravity acceleration, made possible new kinds of trajectory-paths between Mars and Earth, and reduced the travel time enormously.

Some pointed out that this might be possible with ion engines powered by fission reactors. It was agreed that thermonuclear fusion would be far superior in several ways. They explained that fusion energy was the form of energy production which would be needed on Mars, in any case, and that fission-powered ion engines would still take too long to make the trip to Mars. The problem they tackled was convincing the politicians that the needed development of fusion energy had to be completed before the Mars trips began.

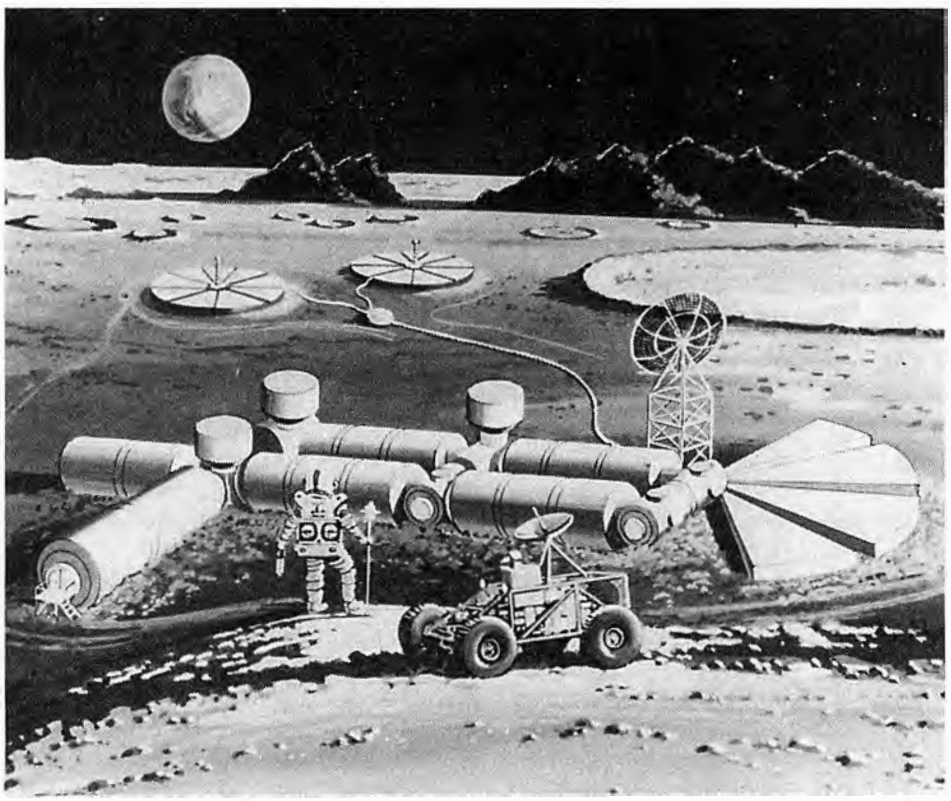
It was decided, at the beginning, that the main part of solving the problem of lifting weight into geostationary Earth orbit from Earth's surface, would be industrializing the Moon. Provided fusion power could be established on the Moon, they guessed that more than 90 percent of the total weight of large space-vessels, could be produced on the Moon, and lifted into Moon orbit at a small fraction of the cost of producing these materials on Earth. The same thing would apply to most of the materials sent to Mars to construct the first stages of a permanent colony. Space vessels to Mars, could be assembled in either Moon-orbit or Earth-orbit, and launched from either place.

The scientists decided, that using a rocket to get beyond the Earth's atmosphere is like designing an aircraft to fly under water. The idea of using a transatmospheric aircraft to get above the atmosphere, had been under discussion for decades, and preliminary designs were fairly well advanced during the course of the 1980s. It was decided to push the development of transatmospheric craft, to build up a network of low-orbiting space-terminals. This would provide the cheapest possible way of moving large numbers of people, and large amounts of freight, up beyond the atmosphere. It would also be the cheapest and safest way to bring people down from orbit to airports



NASA

One design for a space nuclear power system, SP-100, that would provide sufficient power for Earth-orbiting spacecraft, a lunar colony, or a piloted Mars mission.



NASA

Lunar industrialization was necessary to produce and send materials to Mars, for its first permanent colony. Here, a lunar resource processing plant, with two space nuclear power units in the background.

on the Earth.

By that time, there were already designs for what were then called "space ferries." These "space ferries" would carry people and materials over the distance from the low-orbiting terminals, to the locations of the main space terminals, in Earth's geostationary orbit. These geostationary terminals became the locations at which technicians assembled the craft used for regular travel between Earth and Moon.

So, on August 30, 2000, the first routine travel between Earth and the Moon was begun. Some of the astronauts grumbled, complaining that they had become high-paid airline pilots. It was pretty much routine. It was policy, that the pilot made only a few round-trips between the Moon and Earth-orbit, before being sent back to Earth for rest and rehabilitation, although the main Earth space terminals already had a one-Earth-gravity artificial environment at that time. After a few trips, the space-pilots would board a regular bus-run of the space ferry at the space-station, get off at a low-orbiting terminal, and catch the next transatmospheric flight back to Earth.

Few people living in 2036 remember this obscure event, but back in 1986, the United States sent two pilots to prove that a propeller aircraft could make a nonstop trip around the world. Most scientists thought the trip was a silly way to waste money for no useful purpose. The only reason one would mention that obscure flight in 2036, would be to show the kinds of problems the scientists faced in explaining space-colonization to the politicians and voters.

Imagine a propeller aircraft, the combined weight of whose engines, fuselage, and pilots are nearly zero. In other words, how far can a pound of gasoline fly itself, given the efficiencies of propeller aircraft? So, this obscure flight was designed, making the weights of engines, fuselage, and pilots, as small a percentage of the weight of the plane's maximum fuel load as possible. What did the flight prove? Nothing that a qualified aeronautics engineer could not have proven with an electronic hand calculator.

The problem, back in 1989, was to explain to the politicians and public how this same problem, of total weight to fuel weight, limited the possibilities for getting into space, and affected the costs of getting a pound of weight into space. As everyone knows today, the farther a vessel moves from a planet's strongest gravitational pull, the less fuel it costs to accelerate a pound of weight.

The politicians got the point. The system of getting into space, from the Earth's surface to the geostationary space terminal, and to the Moon's orbit, was a kind of pyramid. The dis-

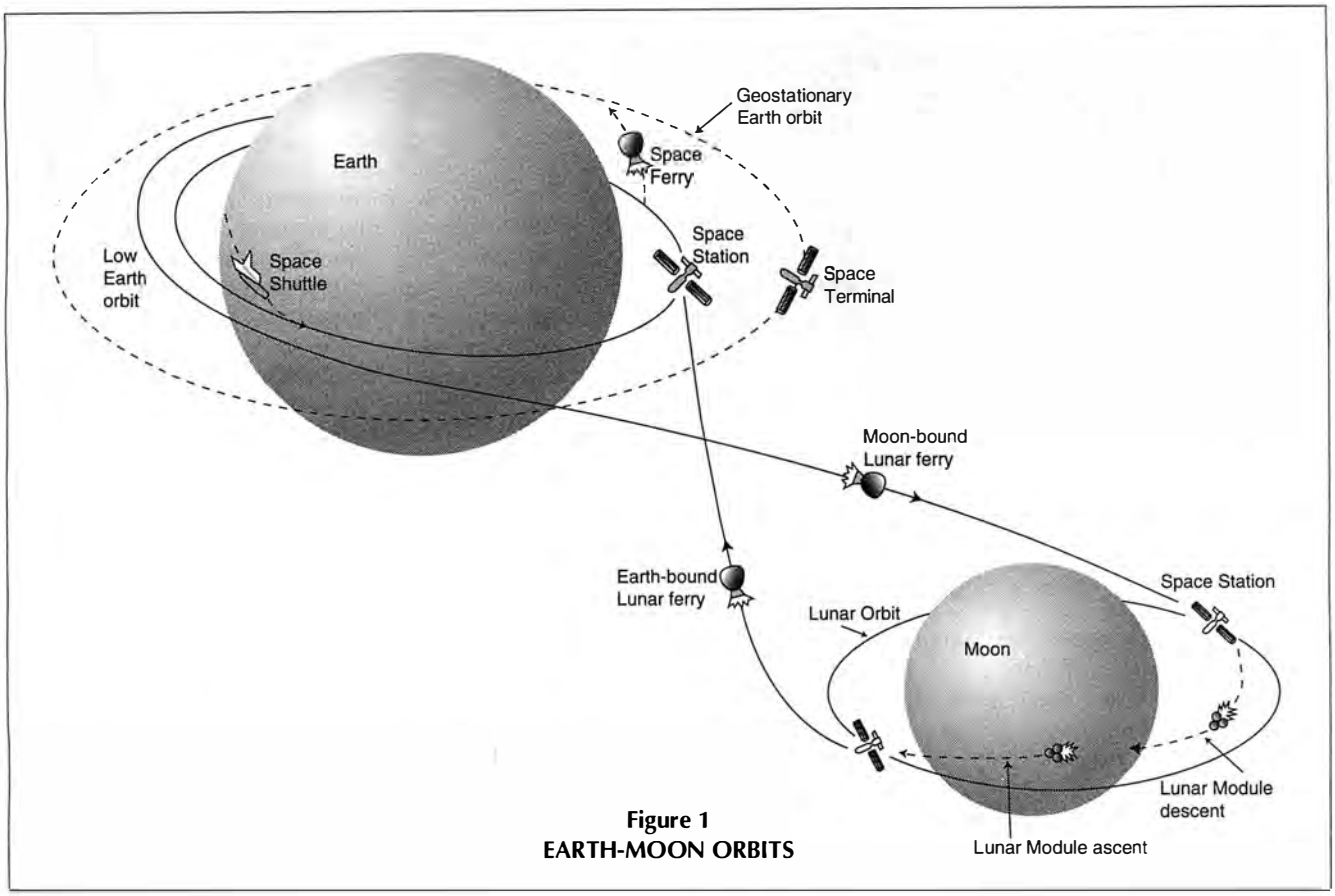


Figure 1
EARTH-MOON ORBITS

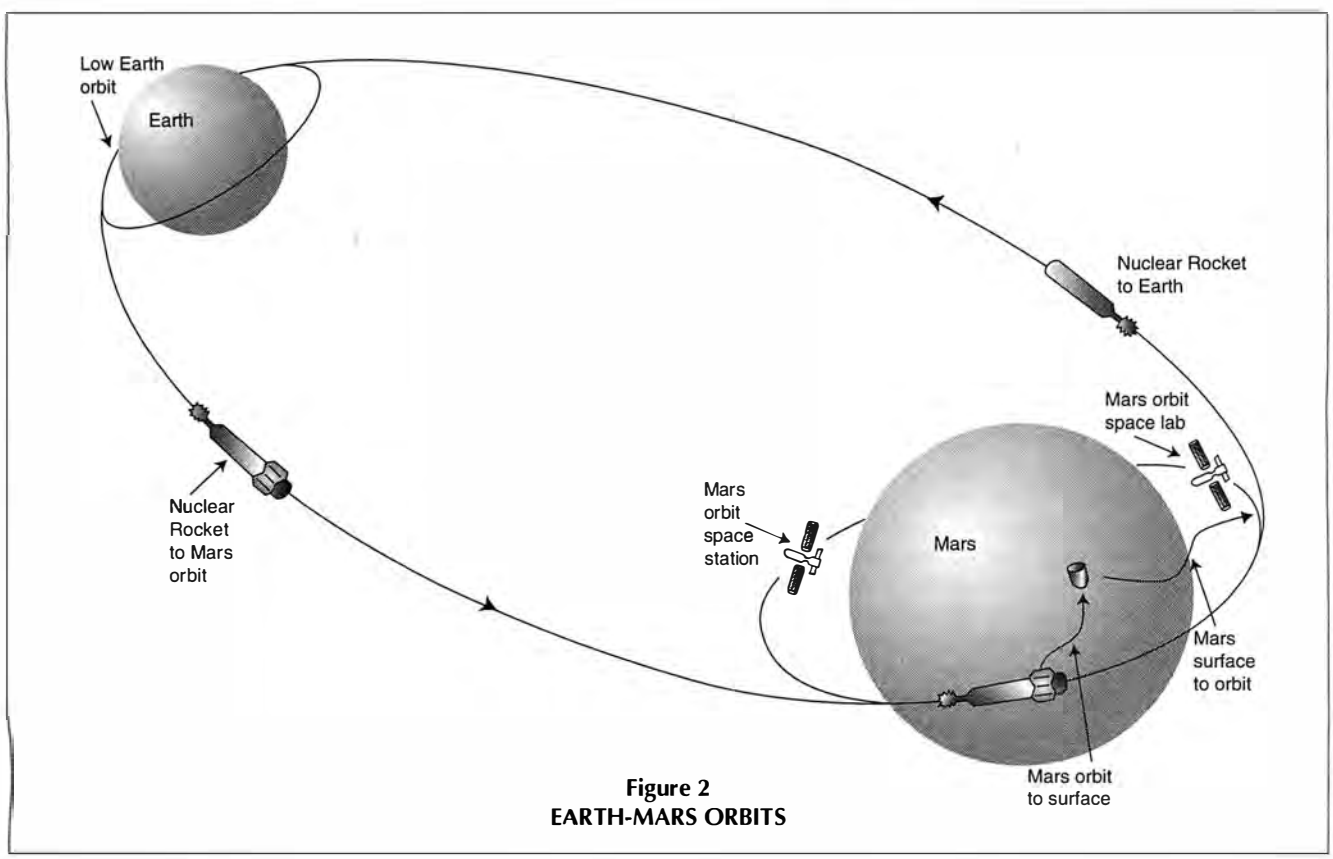


Figure 2
EARTH-MARS ORBITS

Illustration by Virginia Baier

By the early years of the 21st century, space travel became routine. Here, tourists line up at the space terminal.

tance from Earth's geostationary terminal to Moon-orbit, was the tip of the pyramid. The transatmospheric system, between the Earth's surface and the low-orbiting terminals, was the broadest strip of the pyramid. The space ferries, moving back and forth between the low-orbiting terminals and the geostationary terminal, were the middle section of the pyramid.

One of the biggest obstacles the space program had to overcome, was the massive prejudice most of the politicians and public had built up against nuclear fission over nearly 20 years, between 1970 and the time the project began, in 1989. The political factor, of fear of nuclear radiation, was far more important than the engineering problems involved in using nuclear fission safely as a power source for aircraft and space vehicles. This prejudice was a major engineering difficulty, since nuclear fission gives much more power per unit of weight than chemical fuels. In all travel, the ratio of total weight to weight of the maximum fuel load, is the most important of the economic limits to be faced.

However, by that time, thermonuclear fusion as a power source was nearly a reality. Fusion is vastly more efficient as a fuel user, than nuclear fission. So, nuclear fission was the power source for regular flights between Earth-orbit and Moon-orbit during those early years after 2000, but its uses for other modes of flight was avoided.

To get from Earth-Moon to Mars, required us to develop another pyramid, with the base of the pyramid running from Earth's geostationary orbit to the Moon's production facilities, the tip of the pyramid reaching Mars surface, and the distance between the base-line and Mars-orbit the lower portion of the pyramid's volume.

A third pyramid was designed. The base of this pyramid was on Mars's surface. Just as on Earth, we must move passengers and some freight from Mars's surface into Mars-orbit. From there, in Mars-orbit, the pyramid branches in two directions. One direction leads back to Earth-orbit. The other direction was powered travel, as from Earth-orbit to Moon-orbit, to and from the radio telescopes and space laboratories constructed in the general vicinity of Mars.

Those three pyramids became the fundamental design of the system of transportation as a whole.

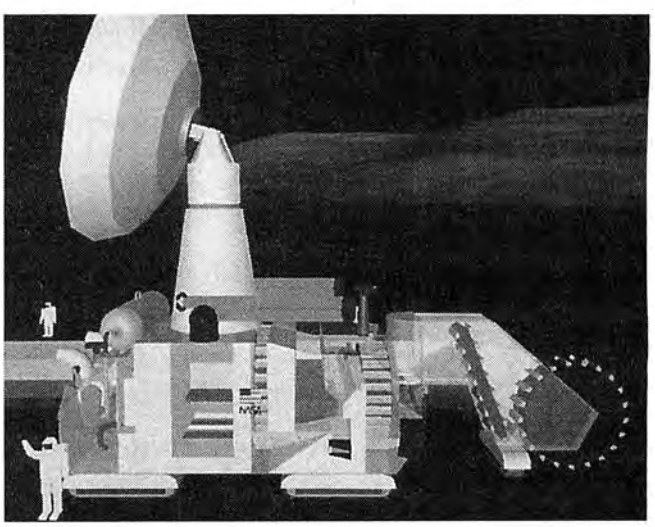
Once the first of the two pyramids had been designed, the key bottleneck next to be mastered, was production on the Moon.

Quite clearly, the scientists could not think of building a 19th-century-style metals industry on the Moon. The combustion of oxygen, which had been the basis for metalworking on Earth deep into the 20th century, was not a workable proposition on the Moon, even if a combustible fuel could be found. Only three sources of industrial energy could be found. Electricity could be generated in various ways, or nuclear fission or thermonuclear fusion could be used. Just past the turn of the century, the fusionable isotope, helium-3 was being mined on the Moon.

Krafft Ehricke had worked out a nuclear-fission economy for the Moon, but it was realized that a thermonuclear-fusion economy would be far better. For the rest, the standard handbooks of physics and chemistry already existing in the 1980s were most helpful.

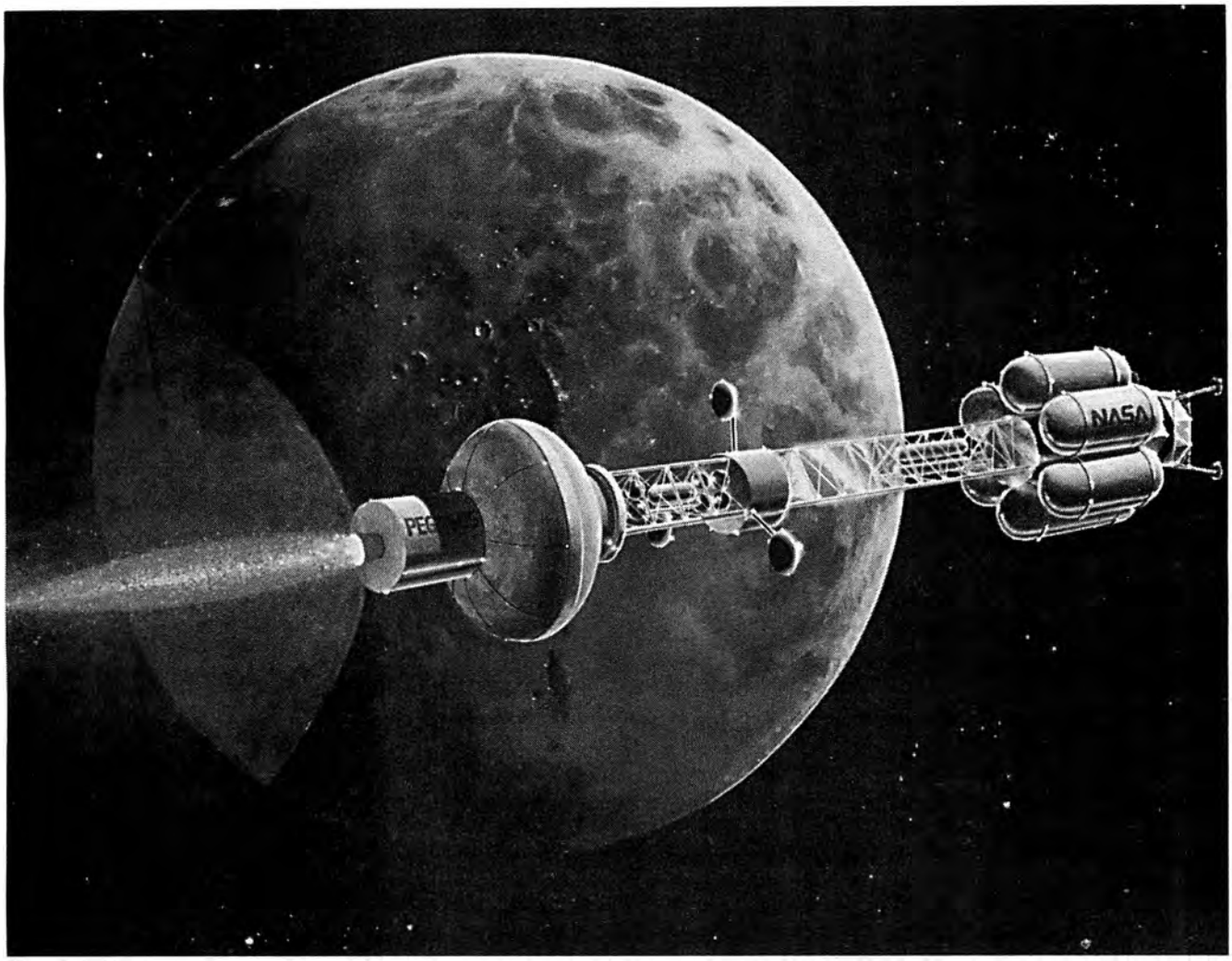
The policy decided upon was this. As every schoolchild knows his ABCs in 2036, production of inorganic materials is a matter of what most back in the 1980s still referred to as the available temperatures of production processes. If the highest industrial temperatures then in general use, could be increased by an absolute factor of slightly less than 10 times existing modes, there was no material in the solar system which cannot be reduced to a plasma form under such conditions. Back in the 1980s, we had only two ways in sight for doing this efficiently, thermonuclear fusion and coherent electromagnetic pulses of high frequency, and very high energy-density cross-section of impact upon targeted materials.

The problem which the project's leaders faced then, was that if we reduce material to its plasma state, how do we handle it? The answer is familiar to every schoolchild in 2036, but



John Andrews/Fusion Technology Institute, University of Wisconsin

There are about 1 million tons of helium-3—a rare isotope of helium, which can be used as fusion fuel—trapped on and near the surface of the Moon. This Lunar Mark-II is a mobile robotic miner designed to process the soil, extract the helium, redeposit the processed soil, and move on. The University of Wisconsin device has a soil processing rate of 556 tons per hour.



NASA

One of the new plasma applications is magnetoplasmadynamic thrusters for use in cargo vehicle propulsion. This artist's drawing shows a high performance electric propulsion cargo vehicle approaching Mars.

it was a major problem for the scientists back in 1989. The key to the solution was obviously lessons learned in experimental efforts to develop thermonuclear fusion as a source of power.

If was clear from the beginning of the project, that if the schedules set for Mars colonization were to be realized, it was indispensable to accelerate thermonuclear fusion development and development of techniques associated with high-frequency lasers and particle beams. The development of the gamma-ray laser was given much higher priority through these decisions. The decision was made, to achieve what were called then "second generation" thermonuclear fusion technologies by the middle of the 21st century's first decade, and to put accelerated efforts behind mastery of techniques for production of materials using electromagnetically confined plasmas.

The fact that we were obliged to force the development of advanced technologies then on the horizon, in order that we might solve the materials-production problems we faced on the Moon, greatly accelerated our civilization's development of newer types of ceramics. We did not have the development of ceramic materials of anomalous crystalline structures on the list of project requirements at the start, but once we recognized the advantages of materials so novel to us at that time, we added the forced development of these technologies to our project.

In the same way, we were forced to develop the early varieties of laser machine-tools in general use in 2036, to be able to machine these new materials. Our project brought the techniques of electromagnetic isotope separation up to a level of refinement still considered modern today.

It was the success of these breakthroughs in fusion, lasers, and very high energy-density production processes, which made the industrialization of the Moon such a brilliant success. It was by perfecting these methods and processes for the industrialization of the Moon that we solved in advance the major problems we would have otherwise faced during the initial colonization of Mars. The building up of the Moon's industrialization was the major factor forcing us to delay the beginning of Mars colonization until 2027. Had we not developed the technologies needed for industrialization of the Moon, as we did, the colonization of Mars would have been delayed by a decade or more.

Some of the 1985-1986 plans included a heavy emphasis on

NASA

The process of lunar industrialization prepared the way for colonizing Mars. Here, a lunar resource processing pilot plant, designed to develop the technologies used for collection, analysis, and both mechanical and electrochemical separation of lunar surface resources; for production of materials needed for life support and propulsion (such as oxygen); and fabrication and construction of structural elements.

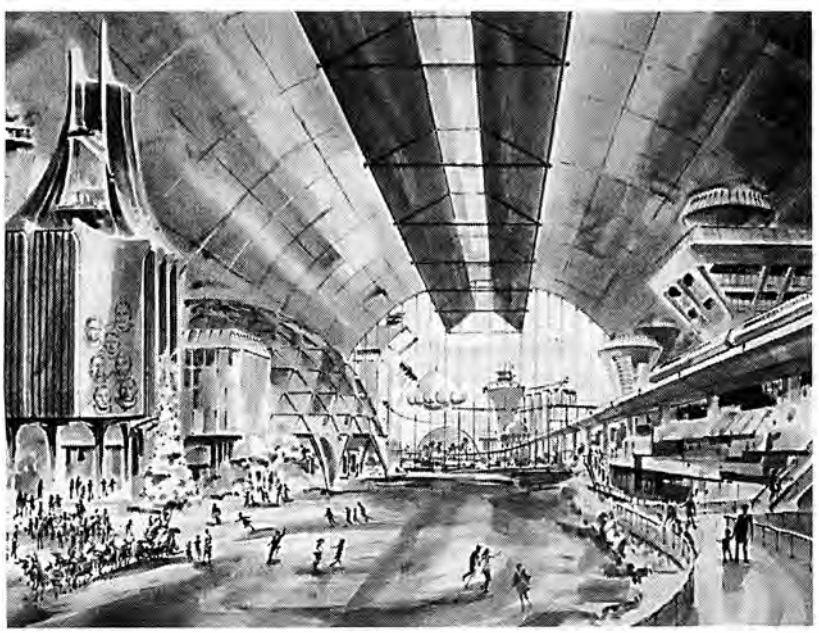


Illustration by Krafft A. Ehricke

Christmas 2031 in Selenopolis—the Moon city envisioned by space scientist Krafft Ehricke. At left is the "Hall of the Astronauts." At right, an elevated monorail train. Behind the transparent insulation is a nodal dome with supplies and life support and climatizing equipment. At the rear is a domed tropical habitat sector.

new directions in biology, but without the desperate fight Earth had to mobilize against the AIDS pandemic, it is doubtful that many supporters of our Mars colonization project would have been won over to supporting this line of research to the degree which later proved necessary, once the Mars colonization had begun. So, today, we are able to incorporate the benefits of this research into designs of systems for manned deep-space explorations, and have overcome most of the fears of possible strange diseases which might be encountered, or might develop, in our further explorations and colonizations of space.

It was not until the late 1990s, that the last significant political opposition to the costliness of the Mars-colonization project was overcome.

We began the project in 1989, under what might seem to have been the worst economic conditions for such an undertaking. Over the preceding 25 years, most of the world had been caught in a long process of economic decline, which we described then as a drift into a "postindustrial society." In many of the then-industrialized nations, the average income of households had fallen to about 70 percent of the real purchasing power of 1966 and 1967. Entire industries which had existed during the 1960s, had either been wiped out, or nearly so, in many of these nations. The basic economic infrastructure, such things as water management and sanitation systems, general transportation of freight, energy systems, and educational and health care systems, were in a state of advanced decay. To cover over the collapse of incomes, a massive spiral of borrowing had occurred in all sectors of government, production, and households; a terrible financial crisis had built up.

Those who pushed the Mars colonization project the most, including the President of the United States, did not view the project as a way of spending a large surplus of wealth. It was seen by them as a way of helping to revive a decaying economy, and also a way of showing all mankind that our species has meaningful opportunities for present and future generations, opportunities as limitless as the universe itself.

At first, many grumbled political objections against the large sums of money spent. As the citizens saw new industries and employment opportunities opening up as a result of the Mars project, the political support for the project grew. Over the course of the first 10 years, the project grew in importance as a technological stimulant to the growth of economies. Then, the first decade of the 21st century, there were waves of revolutionary

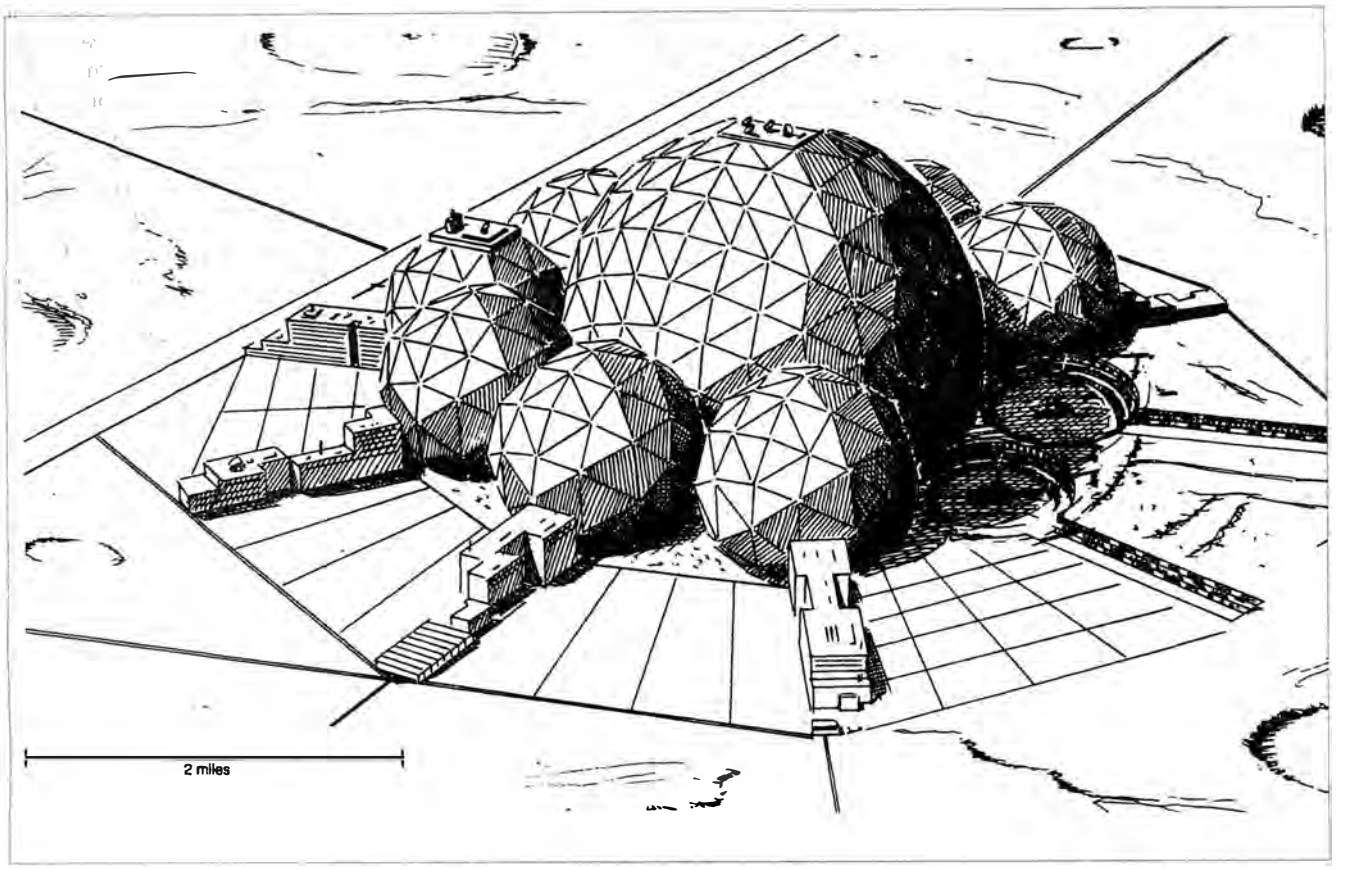


Illustration by Christopher Sloan

Kepleropolis, the first Mars colony, is depicted here in the construction phase. Its main dome, 1 mile in diameter, is built in a crater. Surrounding the main dome are 10 smaller domes, each able to support neighborhoods of 50,000 individuals. The ecliptic of the dome is at ground level. On the surface level is a large educational and recreational park. Immediately below are administrative offices, and on levels below that are transporation and storage facilities and a central fusion power plant. An astronomical observatory and communications station is on top of the main dome.

improvements in methods of production; many of these benefits were the direct result of using the new space technologies in everyday production back on Earth. The political opposition to the project's cost vanished.

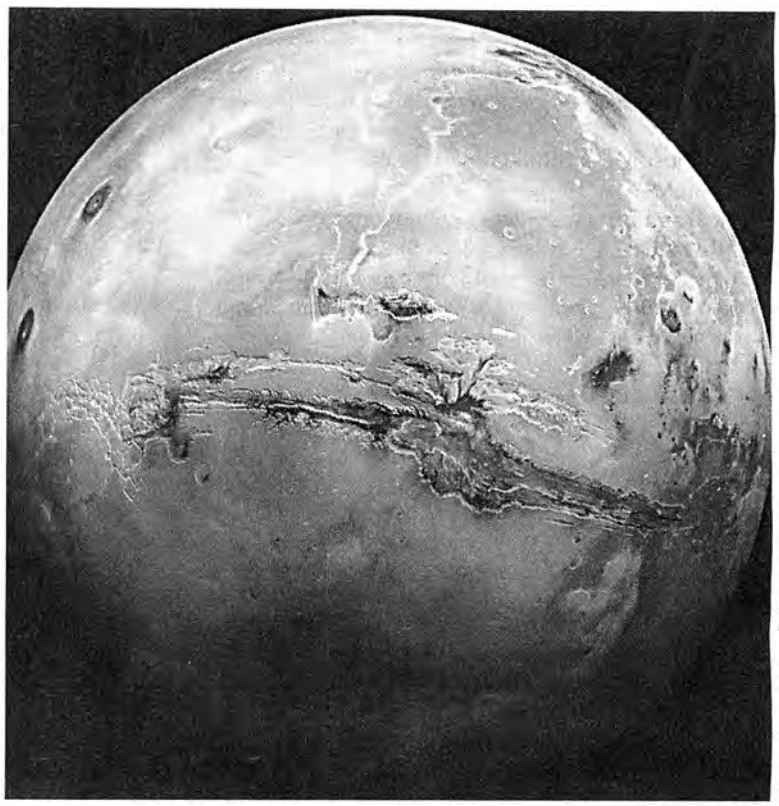
One of the first of the developing nations to join Japan, the U.S., and Western Europe, in the project, was India. The next were Argentina and Brazil. The project's leaders and sponsors showed wisdom in encouraging participation in their own programs by young scientists from many nations. The fact that we may be so confident that general war has disappeared from Earth in 2036, can be credited to the Mars colonization project to a large degree. The rate of technological advancement and increase of wealth in the nations which undertook the project from the start, has been such that no potential adversary would think of attacking them.

As it became clearer to everyone that there were going to be large permanent colonies in Mars during the middle of the 21st century, the general idea of developing the worst deserts of Earth worked its way into policies of governments. Africa, whose population-level collapsed by more than 100 million during the course of the AIDS pandemic, is growing again, and not only the Sahel region, but large stretches of the Sahara are blooming areas with new, modern cities.

No one talks of overpopulation any more. The idea of transforming the Earth-sized moon of Saturn, Titan, into a new colony, beginning 40 to 50 years from now, is already more popular than the colonization of Mars was, back during the late 1980s. Titan's atmosphere is poisonous, but we can foresee ourselves gaining the kinds of technologies needed to Earth-form a planetary body of that sort. The strongest voice for this is coming from the Mars colonists, who now say that they find everything delightful on Mars but its uncomfortably low gravity. There is also big pressure for such new major space projects from circles tied closely to the Moon industrialization program; they say that Moon industries are ripe for a major new challenge.

The Mars colony will be almost self-sustaining within another 10 years. No one on Earth worries any more about Earth's continued subsidy of the colony; who doubts today, that the economic benefits are already vastly greater than the amounts we have spent. There are now over 200 spacecraft traveling back and forth between the orbits of Earth and Mars, and with each journey, more going to Mars than returning. We expect the population to reach over a million within a few years. We wonder if more than a handful living back in the late 1980s dreamed how much their decisions would change not only the world, but the solar system, for the better, within two generations.

The Next Steps to Mars: Probing The Red Planet



U.S. Geological Survey/NASA

by Marsha Freeman

The evidence of past life on Mars has added drama to the upcoming scientific missions that will explore the planet, from the top of its atmosphere into its crust.

From the time that man first looked at the heavens through a telescope, and could note the characteristics that distinguish each of the planetary "wandering stars," Mars has been seen as a hopeful, and often imaginative, distant abode for life. Although until the space age, the planet Venus seemed to hold the same possibilities, the discovery that the temperature on our sister planet would melt lead—never mind life—put Mars in the forefront in the search for life beyond the Earth.

The announcement by scientists on Aug. 7, 1996, that a meteorite from Mars indicates that primitive life existed there billions of years ago, gave renewed encouragement to scientists who had held firm to their evaluation that life *could* have developed on Mars, even though there had been no direct evidence to date, as well as to some who maintain that if life *could* have developed there, it *would* have.

As far as we know, the prerequisite conditions for the development of life existed on Mars at some point in its past. High-resolution photographs of the surface of Mars, from the Viking orbiters, reveal a planet that has been marked by the flow of massive amounts of water. For there to have been liquid water, there would have to have been warmer temperatures, and a thicker atmosphere.

Photographs also reveal a geologically active body, where volcanoes spewed out material from a liquid core within. A planet with an atmosphere, temperatures high enough to allow water to remain in the liquid state, and geologic activity to circulate volatiles (materials that are liquids or gas at room temperature) through the soil and atmosphere, is a body within the boundary conditions for the development of life.

But evidence of past life on Mars might be found not only in fossils, but in their "relatives" alive today. Some exobiologists hold out the hope that when conditions on Mars began to change, to create the cold, dry planet that we see today, the primitive life that had been created, retreated to small niches underground, where internal sources of heat continued to provide liquid water for them to survive.

Underground, however, small creatures would have to have access to a source of energy, entirely isolated from the surface sunlight. Such an organism has recently been found, which lives without *any* contact with the biosphere on Earth, including oxygen, in the Columbia River basalts in the state of Washington. Chris McKay, from the NASA Ames Research Center in California, reports that there was great excitement when such anaerobic organisms—methanogens, which use carbon dioxide and hydrogen to form methane—were found to exist on Earth, because it had been hypothesized that they

Editor's note: This article was written before the failure of the Mars '96 mission; but such a series of experiments should still be carried out in the future.

◀ *Only the flow of water, in immense quantities, could have carved out the massive Vallis Marinaris canyon, which straddles the equator of Mars. Upcoming missions will explore how and when this took place, and where the water on Mars is now.*

are the most likely candidates for the kind of life that may be extant on Mars.

Mars has been an object of continuous interest for scientists in both the U.S. and Russian space programs. The failure of the most recent Mars missions of both nations—the Soviet Phobos mission in 1989, and the U.S. Mars Observer in 1993—has not dampened the enthusiasm for Mars exploration. And the recent discovery that fossils of nanobacteria may be deposited in a meteorite that came to Earth from Mars, and that on Earth there are organisms that, theoretically, could be living on Mars today, has added new urgency to the exploration of the red planet. A series of spacecraft will be arriving at Mars over the next year, and more are planned, which, even though they were not specifically designed to do so, will enhance our understanding of the past and current history of life on Mars.

Plunging Below the Surface of Mars

Next year, for the first time in the history of its exploration—if all goes according to plan—Mars will be invaded by two penetrators, which are part of the Russian Mars '96 mission. The probes, carrying out "Project Visit," will be deployed to the planet from an orbiter, about a month after it arrives at Mars, after scientists have determined where the most fruitful sites would be. The first one will be sent from Mars orbit on its mission, followed a week or two later by the second.

Each 65-kilogram penetrator has a forebody, which is expected to penetrate the surface of Mars to a depth of between 1 and 6 meters, depending upon the density of the material it encounters. The data that can be gathered from that depth will open a new window on the planet, because the surface is covered with a layer of aeolian dust (surface material deposited by the wind), which is surmised to be at least tens of centimeters thick, hiding the interior from the scrutiny of surface landers.

An afterbody, which is attached to the underground part of the penetrator by a cable-rope, will stay largely above the surface, to monitor the weather in the local area, detect any magnetic fields, take photographs, dampen motion from the atmospheric winds, and relay the data gathered from the subsurface part of the probe to the orbiter, from which it will be relayed to Earth.

The forebody of the penetrator contains a highly ambitious series of experiments to probe into the planet. An accelerometer will provide a profile of the density of the soil or rock it encounters, by measuring the rate of deceleration as the probe penetrates the soil. Thermoprobe detectors will measure the temperature of the soil at varying depths, using heat sensors at different parts of the probe.

There is a series of instruments to describe the elemental composition of the soil, by detecting the interaction of the material with emissions from a radioactive source. These include an alpha proton spectrometer, an X-ray spectrometer, and a neutron detector. (The alpha proton spectrometer irradiates the target material with alpha particles and spectra are obtained from the scattered alpha particles and secondary protons.) From these instruments, scientists hope to obtain a profile of the water content of the soil or rock, and its specific chemical composition. A gamma-ray spectrometer designed to reveal the metallic content of rocks, by measuring the spectra resulting from the nuclear reactions of cosmic rays with rock-forming elements on Mars, and the decay of natural radio nuclides, will be close to the surface on the afterbody.

The pre-launch plan is to deploy the penetrators in the northern Amazonis Planitia region of Mars, for it is here, in the northern hemisphere, that the planet shows the greatest evi-

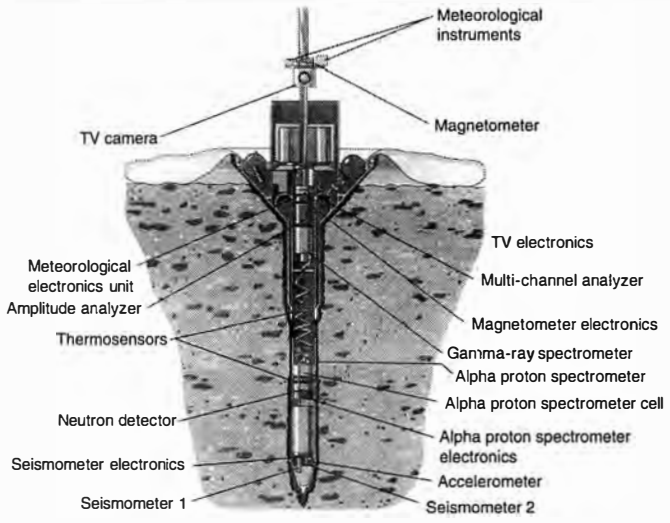


Figure 1
THE 'VISIT' PENETRATOR

The Russian "Visit" mission will employ two penetrators to perform the first subsurface experiments on Mars. A primary task is to describe the elemental composition of the crustal Martian rocks and soil.

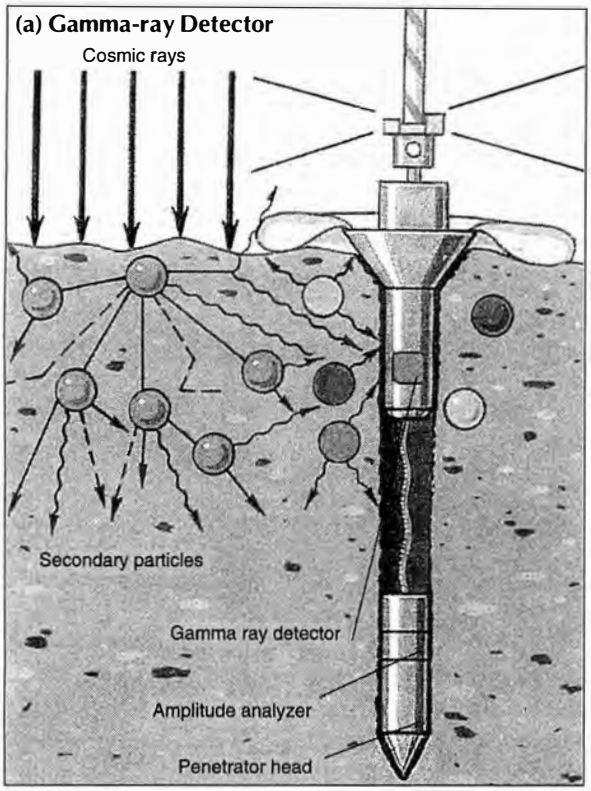
Source: Vernadsky Institute/Babakin Center

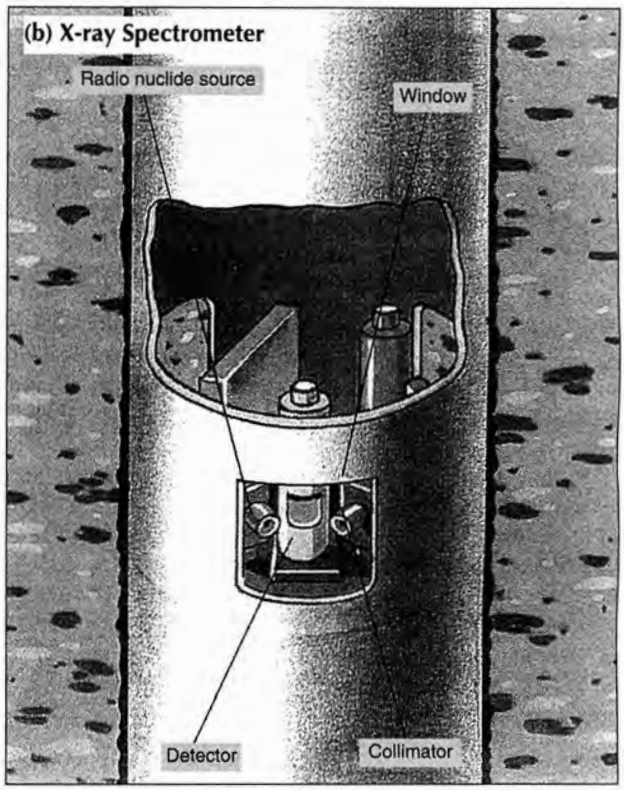
THE MISSIONS TO MARS (1996-1998)

Mission name	Year of launch	Spacecraft	Sponsoring nation
Mars Global Surveyor	1996	orbiter	U.S.
Mars '96	1996	orbiter 2 landers 2 penetrators	Russia
Mars Pathfinder	1996	lander rover	U.S.
Mars Surveyor Orbiter	1998	orbiter	U.S.
Mars Surveyor Lander	1999	lander 2 penetrators	U.S.
Planet B	1998	orbiter	Japan

dence of large-scale geologic activity and water flow.

In order to discern the climatic, geologic, and perhaps biological history of Mars, measurements under the surface will be necessary. Unlike the Moon, on Mars the atmosphere, winds, dust storms, erosion, and seasons, are constantly changing the face of the planet. It is to be expected that the deeper the probe, the older will be the soil, rock, and other structures; the trapped atmospheric gases; and the evidence of water, as is true on the Earth. The data from the penetrators should aid in understanding the evolution of the crust of the





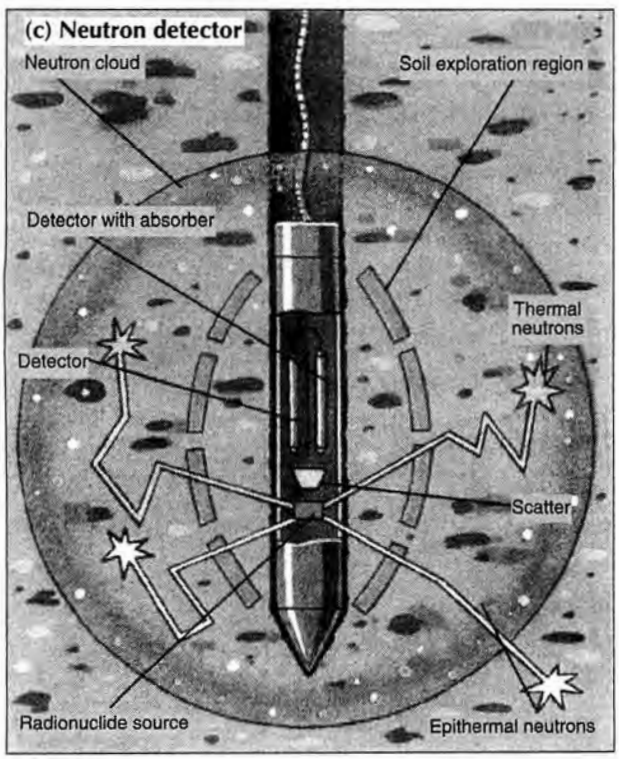


Figure 2
THE 'VISIT' PENETRATOR INSTRUMENTS

(a)
The probe's scintillation gamma-ray spectrometer, "Pegas," is designed to measure the gamma-ray spectra of secondary particles that are generated through nuclear reactions of cosmic rays with Martian elements. This will provide data on the composition of the soil and rock.

(b)
The "Angstrem" X-ray fluorescent spectrometer contains a cell that has closed windows, which automatically open after penetration, for contact with the soil. Radioisotope sources provide the X-rays, and the spectrum of excitation in the soil will reveal its chemical elements.

(c)
The "Neutron-P" detector is designed to determine soil density and the water content of rocks. It will do this by measuring the scatter of neutrons produced by a radioisotope source. The water content of the soil is determined in the sphere with a 30 centimeter radius around the source.

Source: Vernadsky Institute/Babakin Center

planet. The "Visit" penetrators could give scientists their first *in situ* look back in time, at Mars.

Exploring for a Magnetic Field

Magnetometers on the afterbody of the penetrators will discern if there is a slight magnetic field on the planet (none has so far been measured), which would be an indication of the current state of the planet's core. The Mars '96 orbiter will characterize interactions of the uppermost atmosphere of Mars with the solar wind, which will also indicate the presence, or absence, of a planetary magnetic field.

Evidence of any paleomagnetism of the rocks, evidenced by magnetic anomalies above the location of magnetic rocks, could have an important bearing on the recent Martian meteorite discovery.

Exobiologist Chris McKay explains, "It is possible that Mars had a strong magnetic field early in its history, when its core was still liquid, and that bacteria developed to use that magnetic field, just as they do on Earth, by the production of, basically, little compasses." One of the pieces of evidence for past life on Mars presented by the NASA meteorite researchers, is the presence of magnetite near what look like fossil remains of bacteria. Finding evidence of a strong magnetic field on early Mars, could bolster the claim that is being made that the magnetite found in the meteorite is biogenic, Chris McKay says.

This has been one of the most controversial aspects of the evidence presented by the Mars meteorite scientists. In responding to doubt that the current weak magnetic field could produce biogenic responses in Martian bacteria, David McKay and his colleagues write in a letter in the Sept. 20, 1996 issue of *Science* magazine, that even if the magnetite "was internally produced by bacteria on Mars, a 'navigational role' for it cannot be ruled out. Little is known about the past magnetic field of Mars; the field could have been much stronger during the period when volcanism was active on the planet."

In addition to the ferroprobes on the penetrators, the two Mars '96 landers will each have a magnetometer, contributed by the French, to study the elusive magnetic field of Mars. There will also be a series of magnets of varying strength mounted on the U.S. Pathfinder lander, which will collect any magnetic specimens of Martian dust and soil, as small as 100 microns. Images of the plate that collects the particles, when transmitted back to Earth, will allow scientists to help characterize the magnetic history of Mars.

In 1998, Japan will be launching the Planet B spacecraft to try to solve a mystery connected to the question of magnetic fields on Mars. It has been noted through data returned from previous spacecraft that while no magnetic field has been detected around Mars, the deflection of the solar wind plasma around the planet is of a greater magnitude than can be explained by the size and ionosphere of Mars. Planet B will continue the search for a Martian magnetic field, and put under intense scrutiny the ionosphere and upper atmosphere of Mars.

Chemical Reactivity: Is There Life on Mars?

The United States is contributing one scientific instrument for the landers on Mars '96, the Mars Oxidant Experiment, or MOX, which is designed to try to answer one especially vexing question about the history of life on Mars that was created by the data from the Viking spacecraft.

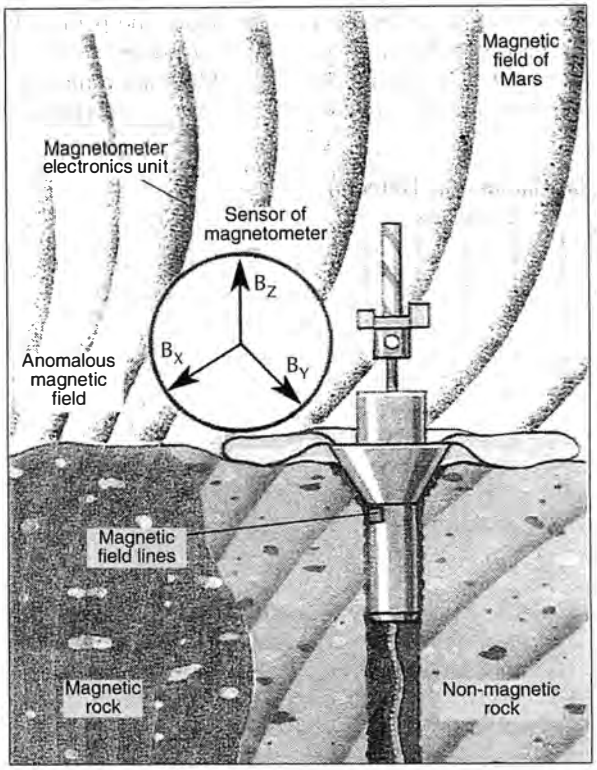


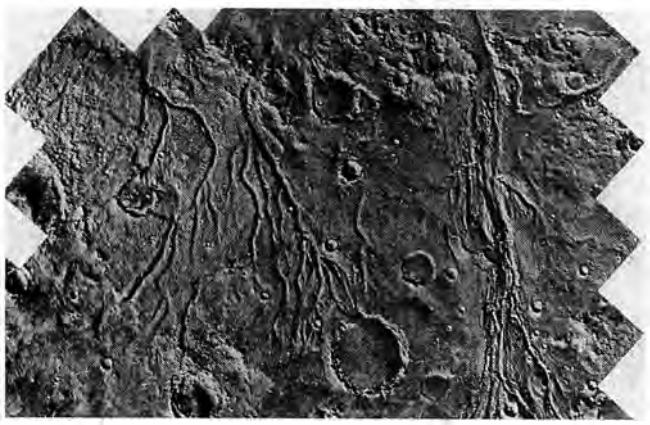
Figure 3
THE 'VISIT' PENETRATOR'S MAGNETOMETER
The "IMAP-7" instrument on the afterbody of the penetrator, is intended to measure the magnetic field that may exist today, as well as paleomagnetism preserved in rocks. The registration of three components of the magnetic fields is possible with the instrument.

Source: Vernadsky Institute/Babakin Center

When the instruments on the Viking lander did an analysis of the surface soil of Mars, no organic materials were found, although the surface was chemically extremely reactive, as if there were organics present. Even if there had never been life on Mars, organic molecules, contributed by carbonaceous meteorites hitting the planet, should have been detectable, but none were. Many of the scientists analyzing the data supposed from these results that oxidants—certain inorganic, chemically reactive species—caused the reactivity of the soil observed by Viking, and that these chemicals destroyed any organic molecules that were present. On Earth, two of the most common oxidants are hydrogen peroxide and ozone.

According to Marsha Presley, a postdoctoral associate at the NASA Ames Research Center, these oxidants could be created on Mars when the Sun's ultraviolet rays break down the carbon dioxide and water that is in the atmosphere. The Mars Oxidant Experiment will attempt to identify the composition of oxidants and measure the oxidation rate of the environment.

The principal scientist involved in the Viking experiment that discovered the reactivity of the Martian soil, Dr. Gilbert Levin, has put forward another hypothesis. First, he demon-



NASA

The force of flowing water is clear in this mosaic of the Mars surface, made of pictures taken from the Viking 1 orbiter, in September 1976. The channels are suggestive of massive flooding from the Lunae Planum region of Mars. Some channels cut through craters, while in others, the craters are younger than the channels.

strated that the gas chromatograph/mass spectrometer, which had indicated there are no organics on Mars, is not as sensitive as scientists had thought. When a copy of the instrument was taken to Antarctica, it did not register any evidence of life there, either, so its results should not be interpreted as being final; there may well be organic materials on Mars.

Second, Levin has insisted for 20 years that the results from his Labeled Release experiment on the Viking lander indicated that there is life on Mars. Therefore, he says, the Viking results must be seen as inconclusive, not a definite "no" in the question of life on Mars. Levin will have an opportunity to further test his conclusion as the data come in from the Mars Oxidant Experiment.

Ingenious micromirror chemical sensor technology developed by Sandia National Laboratories is the heart of the Mars Oxidant experiment. The ends of 96 optical fibers are coated with thin films of different materials that will react during exposure to chemicals in the Martian soil and atmosphere. Changes in thickness at the coated end of the optical fibers, caused by the reactions, alter their reflectivity. Light emitting diodes provide illumination at two different wavelengths, and a conventional photodiode detects the reflected light.

Scientists chose the films for their reactivity to certain chemical compounds and they hope that the reactivity of some fibers, and the nonreactivity of others, will identify oxidants in the Martian atmosphere and surface material. Three of the films were chosen to be able to discern whether the environment is acidic or basic in nature.

Dr. Levin is one of the scientific investigators on the MOX experiment on the Mars '96 landers. After a lot of pulling and pushing, he succeeded in including on MOX, two fibers coated with an amino acid, cysteine. The fibers are coated with L-cysteine and D-cysteine, the left- and right-handed isomers of the same amino acid. If there is a reaction with the Mars soil to the left-handed isomer, Levin says, it will indicate a life form similar to those on Earth, which are also preferentially left-handed.

If there is no reaction to the amino acids, he explains, it would "cast grave doubt on the oxidant theory," although it wouldn't mean that life *was* present. If the reaction from the soil is to the right-handed isomer, then there is life on Mars, but it is different from life on Earth, Levin says. And if there is equal reaction to both isomers, one can assume it is just a chemical reaction, and not evidence of biological activity.

The Mars Oxidant experiment will provide information that will "reduce our uncertainty," according to Chris McKay, who heads the science team that will be poring over the data from the experiment. If MOX found oxidants, and if later generations of the Mars Oxidant instrument were to find that such chemical destruction of organic molecules extends deep into the planet, the chance of ever finding the remains of ancient life on Mars could be remote. But Levin thinks that evidence of life will be found, not oxidants.

Searching for Signs of Water

On the Earth, the examination of fossil remains and highly sophisticated analysis of gases and minerals in subsurface soil allows scientists to trace back the history of the development of life on this planet. Until samples of Martian soil and rock are brought back to Earth-based laboratories for careful scrutiny, and until scientists go to the most likely places where fossil remains of life may exist on Mars, to search for themselves, they will attempt to recreate theoretically what might have been the preconditions for the development of life on Mars, largely through indirect evidence, making use of scientific instruments mounted on orbiting spacecraft.

Since the major prerequisite for life is water, discovering the history of liquid water on Mars is key.

The two key markers in the history of water on Mars that can be investigated most efficiently from orbit are its surface features and the global atmosphere. The Viking orbiters in the mid 1970s produced a comprehensive geological survey of Mars, revealing a planet with canyons etched out of the rock and soil, dry lake beds, and outflow channels, all produced by the discharge of liquid water.

The action of water on the landscape of Mars will be under investigation by the instruments aboard the orbiter of the Russian Mars '96 mission, and the U.S. Mars Global Surveyor, both of which will arrive at the red planet next September. Both will be in near-polar orbits, rather than equatorial orbit, able to examine the entire planet periodically, as Mars turns west to east underneath the spacecraft.

The Mars Global Surveyor carries a camera that will produce narrow-angle images of objects as small as 1.5 meters across, to reveal fine structures and intricate effects of the action of water on the surface of Mars. The camera will also be taking wide-angle images, for global features, with resolutions of 1 to 4 kilometers.

In a complementary fashion, the high-resolution camera aboard the Mars '96 orbiter will fill in the gap, by producing stereoscopic images with a resolution in the tens of meters, thanks to contributions to the Mars '96 mission by Germany and France. These high-resolution images will be taken for only a short time on each orbit. This is because of the Russian orbiter's fuel limitations, which will keep it in a highly elliptical orbit, not a circular orbit. The orbiter will come to within 500 km of the surface of the planet for a relatively brief period of each orbit, at its closest approach, but go out to 40,000 km at its farthest point.

With finer resolution of the surface characteristics that have

been produced by the action of water, it may be possible to begin to construct a timeline of the ancient climate of Mars, indicating when liquid water appeared on Mars, how long liquid water flowed on the surface, and at which points in time the climate began to change, the temperature fell, the water began to freeze, and some of the volatiles were lost to space, leaving the cold, dry planet that we observe today.

In addition to taking photographs of the surface features of Mars, the two orbiters will examine the evolution of changes in the surface of the planet using other techniques.

A *laser altimeter* on board the Mars Global Surveyor will produce a profile of the topography of successive sections of the surface—the height of its mountains and depths of its valleys—by firing short laser pulses at the surface 10 times per second, and measuring the time the reflections take to return. The map it produces will have an accuracy to 2 meters.

A *long-wave radar instrument* on the Russian Mars '96 orbiter will be able to supplement local data from the series of penetrators on the planet, with global soundings to reveal subsurface features. As Tom Duxbury from the Jet Propulsion Laboratory explains, radar soundings will be able to penetrate the surface up to 50 meters, primarily in regions between about 30 to 40 degrees of the equator, during the day or night. Such soundings could add substantially to our knowledge of the history of water on Mars, delineating the boundaries between soil and ice, and locating large blocks of ice if they exist under the surface.

Although the design of this instrument is different from the synthetic aperture radar instrument NASA has flown on the Space Shuttle, the value of using radar sounding in dry terrain has been demonstrated by astronauts on the Shuttle, through the location of ancient dry river beds under the deserts of the Middle East.

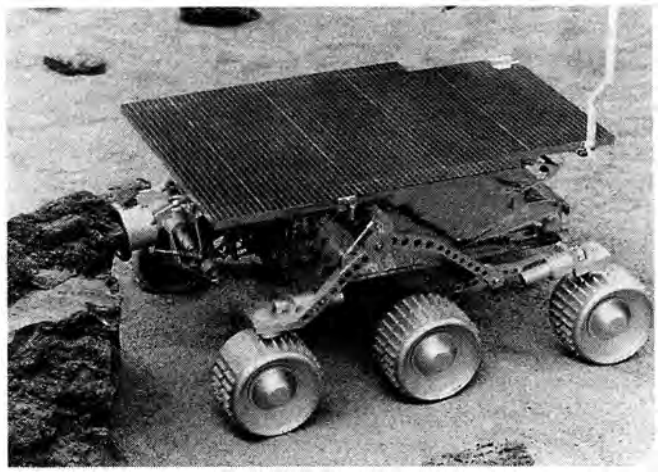
The U.S. and Russian orbiting spacecraft not only will provide a detailed map of the geological characteristics of Mars, in looking for the history of water on the planet, but also will extend our ability to search for other telltale signs of water on Mars.

The Mars Global Surveyor carries a *thermal emission spectrometer,* which will map infrared emissions from the planet in the range of 6.25 to 50 micrometers, at a surface spatial resolution of about 3 kilometers. The Russian Mars '96 orbiter carries an infrared mapping spectrometer, as well. By measuring emissions in the infrared, scientists expect they will be able to detect certain key minerals, such as carbonates, that would have formed from water on the surface and carbon dioxide in the atmosphere. This would be "important confirmation" of the hypothesis of the ubiquity of water on Mars, according to Chris McKay.

Thermal emission instruments will also determine how hot and cold the surface gets during the day and night cycles on the planet, how well the rocks and soil transmit heat, the distribution of rock and grain sizes, and the amount of the surface that is covered by large rocks and boulders.

Sojourner "Interrogates" Rocks

Another important tool in the search for water in Mars's past will be the U.S. Pathfinder lander, due to arrive at the planet on July 4, 1997, before either of the two orbiters. A passenger on the Pathfinder lander, the 22-pound microrover Sojourner, will be deployed from the lander to search out rocks of interest to scientists, and analyze them using an alpha-proton-X-ray spectrometer. A small piece of radioactive curium-244 on board the instrument bombards a rock or soil sample with alpha-particle radiation. Some particles will interact with the sample and result in the emission of protons or X-rays.



NASA

The microrover, Sojourner, demonstrates here how it will examine rocks on Mars next July. At the left, protruding from the body of the rover, is an alpha proton X-ray spectrometer, which will collect the spectra of the rock over 10 hours to determine its composition. The instrument was provided by the Max Planck Institute of Germany, and the University of Chicago.

The number of backscattered alpha particles, protons, and X-rays counted by the detector and the number of particles at each energy level, relates to the abundance of types of elements in the soil or rock. A high-quality analysis requires about 10 hours of instrument operation, but this can be done at any time, during the day or night. The rock's spectrum, measured by the rover, will be relayed to the lander, and then back to Earth via the Mars Global Surveyor orbiter, where the composition of the rocks can be determined.

The Pathfinder is targetted to land, and deploy the microrover, in the Ares Vallis region of Mars, "which is a place where water flowed at one time," Chris McKay reports. "It's a place where an outflow channel has obviously dumped onto the plains. We might find minerals which are consistent with, or indicative of, precipitation of water." If sedimentary rocks are found, "it would be good evidence of past liquid water activity at that site," according to McKay. Pathfinder project scientist Matthew Golombek told reporters at a NASA briefing Oct. 16, 1996, that finding sedimentary rocks would be "stupendous," because such rocks preserve a record of the environmental conditions under which they formed, and consequently, preserve evidence of any climate changes that occurred through time.

Photographs and other data have shown there is still water ice at the poles of Mars. It is surmised that there is also an inventory of frozen water, perhaps in the form of permafrost, in the soil. But in order for there to be life on Mars today, there has to be *liquid* water. Scientists theorize that this would be possible if there were volcanic activity recently enough for there still to be thermal vents producing an underground source of heat. Meteorites from Mars are again a window to a past that could have provided an abode for life.

NASA

This composite of photos taken from the Viking 2 orbiter shows the North pole in midsummer, when the carbon dioxide cap recedes, revealing the water ice and layered terrain. At this resolution, the steps of the layers are about 50 meters thick. The regularity of the layers suggests their connection to periodic seasonal and climatic changes.

The recent discovery, pointing to the existence of life on Mars 3.5 billion years ago, was made analyzing one of a dozen meteorites from Mars that have been found in Antarctica. The others are considerably younger, and one group is only 200 million years old. This indicates that as recently (geologically) as 200 million years ago, there was volcanic lava flowing on Mars, some of which crystallized at that time, and small pieces of which were expelled and found their resting place on Earth.

Scientists think that if Mars had volcanic activity that recently, it "bodes well for the notion that it might still have active geothermal areas," according to Chris McKay. There is a possibility that the intense scrutiny Mars will soon be undergoing by orbital spacecraft will reveal geologically active regions where such thermal vents exist today.

What's the Weather on Mars?

It will not be only from the geological record that a global picture of ancient Mars will emerge; the weather and climate on Mars today can help to reveal whether the conditions necessary for the development of life existed over a long enough period of time for life to have developed. In addition to understanding the history of the availability of water on Mars, the history of liquid water, water vapor, and ice on Mars also plays an important role in the climatic changes on the planet.

The Viking orbiters revealed that both the north and south poles of Mars have caps of frozen carbon dioxide that advance and recede with the change of seasons. At the north pole, there is a small residual cap that remains in midsummer, composed of water ice. There is a smaller cap left in summer at the south pole, although temperature measurements indicate it to be frozen carbon dioxide.

At both poles there are distinctive, layered deposits, most visible in the summer when ice recedes from the poles, and water and carbon dioxide vapor is absorbed into the atmosphere through sublimation. The layered terrain is nearly devoid of impact craters, indicating that it is young in age and perhaps continually in formation, even to the present time. From the available photography, it appears that some of the layers are in the range of several tens of meters in thickness.

NASA

The ellipse indicates the landing site for the Pathfinder lander and rover, Ares Vallis, in the Chryse Planitia region in the northern hemisphere of Mars. The Ares Vallis channel was formed through the release of water from the Martian subsurface that flowed across the surface, from the northwest to the southeast. The water created the channels and the large islands seen to the south and northeast of the landing ellipse.

Scientists surmise that this layered terrain is created by the deposition of the dust carried by the winds to the poles, possibly volcanic action, and cyclical changes in climate, evident in processes such as glaciation.

The Mars Surveyor 1998 mission, being planned by NASA, will include an orbiter, focussed on understanding the weather, and the climate history of Mars, and a lander and two penetrators, which will conduct *in situ* studies of the south polar region of Mars. Scientists consider the poles of Mars key to understanding the planet's global climate fluctuations.

From an altitude of 400 kilometers, the orbiter has the objectives of identifying surface reservoirs of volatiles and dust, searching for near-surface ground ice in the polar regions, monitoring the key parameters of the atmosphere, and exploring the onset and decay of dust storms.

To study the temperature, water vapor, dust, and condensates in the atmosphere, the orbiter carries the *Pressure Modulated Infrared Radiometer (PMIRR)*. According to program manager John McNamee, this 44-kg instrument will be sounding the atmosphere, and by reporting on the dust and water vapor, will be able to track the migration of materials from the equator to the poles. It will provide temperature, water, and dust profiles from the planet's surface to an approximate altitude of 80 km.

Richard Zurek, project scientist for Surveyor 1998, says that scientists expect the infrared soundings to show an atmospheric temperature difference between day and night that changes, depending upon how much dust there is in the atmosphere. This is one way that the wind-blown dust on Mars could have climatic consequences. Zurek expects there will be less of a diurnal range on the ground, where less radiation penetrates during the day, and less is emitted at night. Surveyor 1998 should observe daily variations in the Mars atmosphere, which are described as atmospheric tides.

The weather on Mars can be cloudy, and also foggy. The fine structure of clouds, which are made up of water ice and dust, can reveal information on the winds on Mars, Zurek says, and can be combined with temperature measurements to help develop a weather model for Mars. Although the atmospheric pressure on Mars is only one hundredth of that on Earth, the Viking orbiters did note changes in the pressure, wind velocity, and temperature when a weather system passed over the planet. Zurek thinks there may be a Hadley circulation cell in the atmosphere of Mars, leading to a "massive turning over" of the atmosphere.

The *Mars Color Imager (MARCI)* system will provide details of the interaction of the atmosphere with the surface, at a variety of different scales, in both space and time. A series of color filters for the two MARCI cameras will provide measurements from the ultraviolet to the near infrared.

The high resolution polar photographs from the 1970s Viking mission were only of the north pole, because a dust storm disrupted measurements at the south pole. Zurek believes that water ice will also be found at the south pole during the Surveyor 1998 mission, formed when water vapor in the atmosphere comes into contact with the cold carbon dioxide ice at the pole.

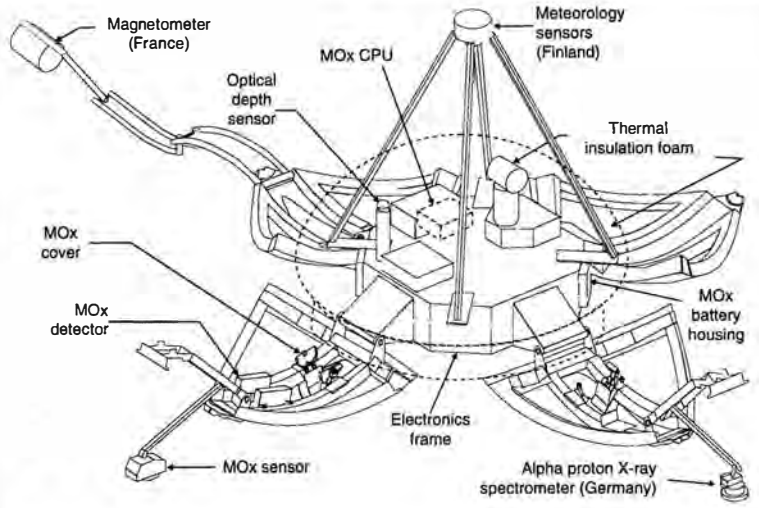


Figure 4
MARS '96 LANDER

The U.S. instrument on the Russian Mars lander, is the Mars Oxidant Experiment. Designed to test the Martian soil for oxidants, to explain the soil's reactivity, it could also give us another indication of whether or not there is life on Mars. The MOX detector will examine the atmosphere, and the MOX sensor, the soil.

Source: Sandia National Laboratory

At an Oct. 16 press briefing on the 1996 Mars missions, held at NASA headquarters in Washington, D.C., Administrator Dan Goldin promised that there will be daily weather reports from Mars, which will be available to anyone with access to the Internet. The Surveyor 1998 orbiter will pick up where the 1996 mission orbiter leaves off, but with more of a focus on climate and weather than its predecessor. It is hoped, however, that both orbiting spacecraft will be in operation for some overlapping period of time.

The polar lander mission is slated for the 1998 launch opportunity (actually, January 1999), to take advantage of the fact that when the spacecraft arrives in December 1999, the south pole will be in sunlight during the 90-day primary science mission. This condition will not recur for more than a decade.

The Surveyor 1998 lander will be heading for a target region at 80 degrees south latitude, at the edge of the ice cap, when it is late spring in the southern hemisphere, according to John McNamee from the Jet Propulsion Laboratory. The lander has a robotic arm that will be able to dig about a half meter (20 inches), at best, into the Martian soil. A depth of six inches or more is important, McNamee reports: At the poles, scientists expect to find subsurface ice that near to the surface. It is widely believed that the bulk of the water that was once liquid on Mars, is now trapped in the soil as permafrost.

The 2-meter remote arm will bring a soil sample to the *Thermal and Evolved Gas Analyzer,* where it will be heated, and then the hydrogen and carbon dioxide that is evaporated will be measured, to estimate the amount of ice in the sample. Scientists hope the scoop on the arm will also be able to dig a shallow trench in the soil, so a camera at the end of the robot arm can photograph the exposed terrain.

Dr. Zurek expects that Surveyor 1998 will find the layered terrain is of a finer structure than has been thus far seen in the images from Viking, and that the deposits could even be annual, deposited with the change of seasons. Overall, however, it is not known if the layers are increasing or eroding, which would have climatic consequences. It is also possible, Zurek surmised, that there were years when layering did not take place; that is, there could be "missing sequences" found in the terrain, which could indicate a disruption in the cycle of seasonal variation.

A *LIDAR (Laser Detection and Ranging) Atmospheric Sounder* on the lander, furnished by the Space Science Institute in Russia, will determine the dust content in the atmosphere, and provide "ground truth" to measurements being taken from orbit. These data, on dust and haze in the polar atmosphere, will be unique. The camera on the Surveyor 1998 lander will enable scientists to see individual particles of dust, the shape of which, according to Zurek, can reveal how long they have travelled in the atmosphere.

Martian dust storms last for weeks at a time, and the large ones, which are global, are seasonal, starting in the southern summer and spring, when Mars is closest to the Sun. Forecasting the weather on Mars will emphatically include tracking, and eventually predicting, dust storms, which are not necessarily annual. The Viking spacecraft observed only two global dust storms over a period of four Mars years.

Searching for Ice

Hitching a ride on the Surveyor 1998 lander are two extremely small penetrators, developed in the NASA New Millen-

nium program, referred to as Deep Space II. The microprobes each weigh about 2 kg, and scientists expect them to penetrate between 0.3 and 2.0 meters below the polar region's soil. They will be deployed from the lander just prior to entry into the atmosphere, and land about 200 km from it.

Two of the most important questions the penetrators could help answer, according to Mars microprobe flight scientist Sue Smrekar, are: Is water accumulating in the subsurface at present, and at what depth is the ice stable? Such data will aid scientists in determining what climatic cycles may have existed in Mars's past.

The data collected by Surveyor 1998 on the amount of water at the poles will be used to test models that describe the transport of volatiles between the atmosphere and the near surface. Smrekar explains that an *in situ* study of the soil near the pole will be important, because the long-term inventory and characteristics of water on the planet depends upon soil properties.

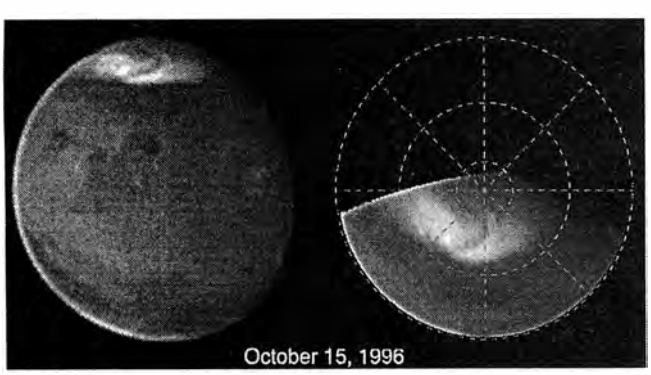
Considering their diminutive size, the microprobes are expected to return an impressive array of data. Mars Microprobe flight leader Sarah Gavitt, at the Jet Propulsion Laboratory in California, explains that there are three scientific objectives for the penetrators: to determine if ice is present in the subsurface, to measure the local atmospheric pressure, and to characterize the thermal properties of the soil.

First, each probe has a soil sample chamber where soil will be heated and resulting water vapor detected, using a tunable diode laser. Only one sample will be tested by each probe.

Second, a pressure sensor on the afterbody of the penetrator will measure the local atmospheric pressure above the surface, and will collect data as long as the penetrator has power. The batteries are designed to power the penetrators' operations for 50 hours, but there is a possibility they may operate for up to two weeks.

Third, the microprobes are designed with sensors in two different positions on the forebody of the penetrator in order to characterize the thermal properties of the soil. The heat conductivity of the soil will also be derived from how quickly the probe penetrates the soil.

There is a chance that the relatively pristine poles of Mars, although too cold to host life at the present time, could have preserved life from the past. Chris McKay speculates that, if this ice has been frozen for billions of years, it is possible that it has preserved within it, fossils of living creatures that developed billions of years ago. They would be found deep in the permafrost where the ice is stable, and not subject to thermal waves caused by the annual obliquity cycle of the planet, McKay says. At the Earth's south polar region, scientists, including McKay, have actually found dormant organisms frozen in the permafrost, that came back to life when warmed.



NASA

In this photograph, taken October 15, 1996 by the Hubble Space Telescope, scientists observed a dust storm the size of the state of Texas, churning just at the edge of the north polar cap. Predicting such seasonal dust storms will be vital for the future landing of spacecraft, and men.

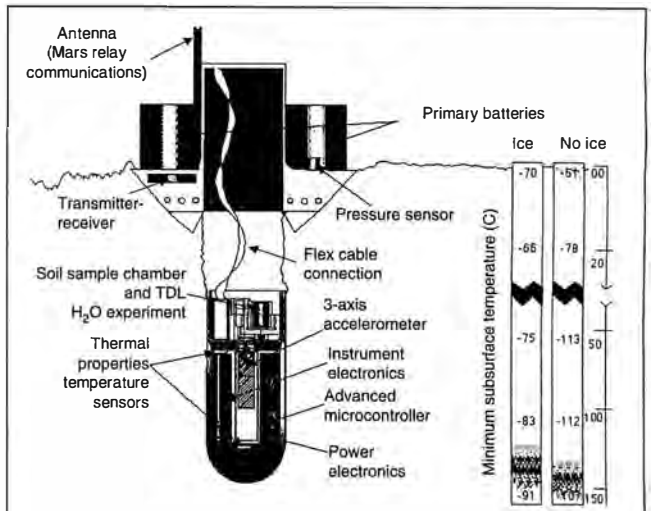


Figure 5
SURVEYOR 1998 MICROPROBE

The tiny Surveyor 1998 microprobes will be landing near the south pole. They will measure the water ice content of the soil, and its thermal properties, to help solve the mystery of where the liquid water that was on Mars, is now.

NASA/JPL

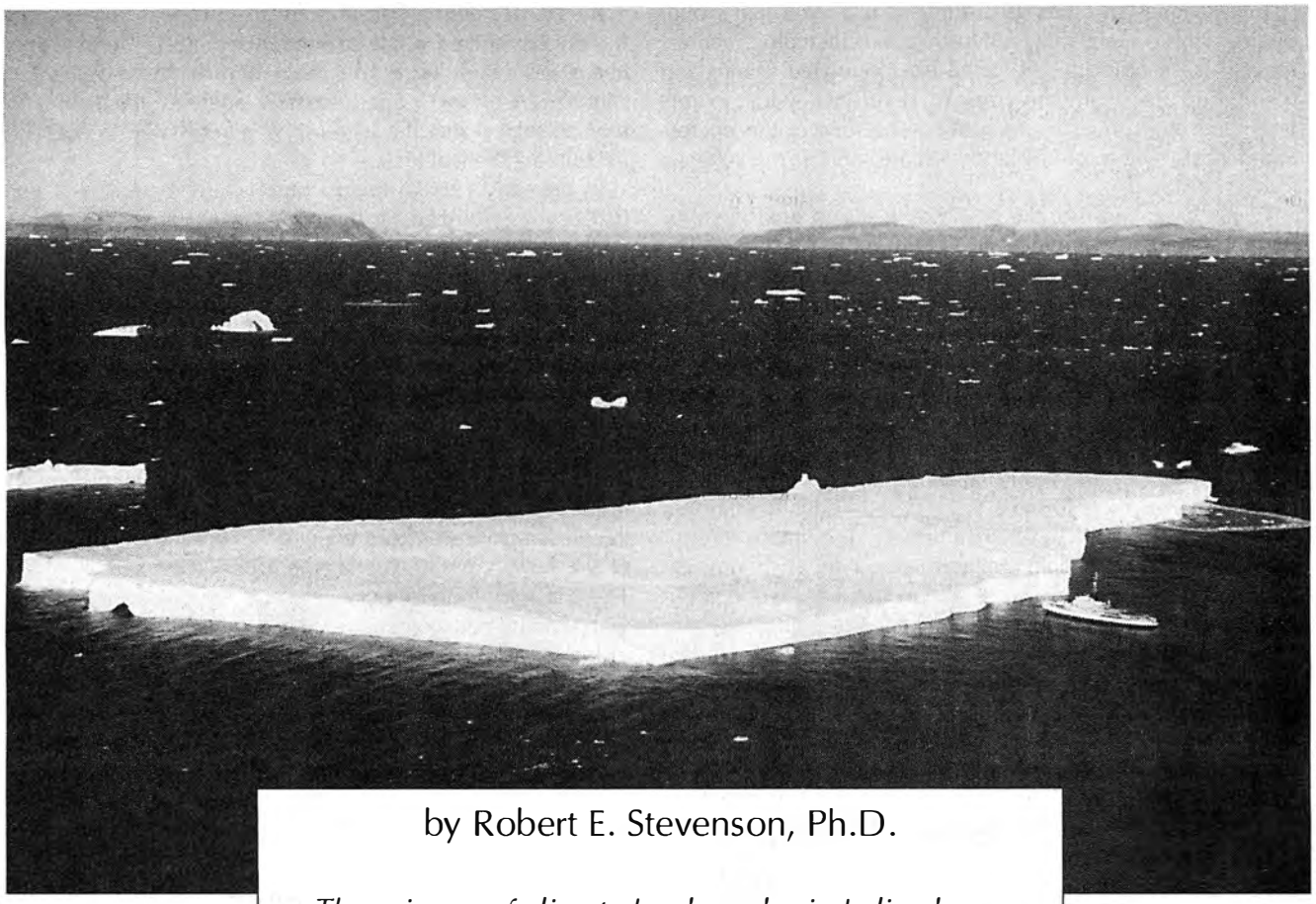
As is the case on Earth, the accuracy of local measurements of the atmosphere, subsurface, and surface will depend in part upon the number of data points. Networks of landers and probes, perhaps 15 or 20 of them, Sue Smrekar suggests, will be the next step for Mars exploration, after the turn of the century. A key network of subsurface microprobes will be needed for seismological studies on Mars: The seismometer on the Viking lander vibrated in the wind.

NASA currently plans to send spacecraft to Mars 26 months apart, when the relative positions of the two planets makes such missions most efficient, through the year 2005. By that time, scientists should be able to describe the history of Mars, and its climate and geological activity. By the year 2005, a mission should be on its way to bring back rock and soil samples from specific locations on Mars that are considered the most promising in the search for life on the planet, as determined from the spacecraft that went before.

But there are few who believe that whatever scientists learn from samples of soil and rock brought back to Earth by a robot will be conclusive. Only when men go and explore for themselves, will the question of whether there is, or has been, life on Mars, be answered. We will be able to answer the question because there will be life on Mars in the future.

Marsha Freeman is an associate editor of 21st Century.

An Oceanographer Looks at the Non-Science of Global Warming



U.S. Coast Guard

by Robert E. Stevenson, Ph.D.

The science of climate has been buried alive by an avalanche of ideology-based computer models.

Not so long ago, in the early 1970s, climate scientists thought in 100,000-year cycles, or at least 10,000-year cycles, and were talking about global cooling. Scientifically speaking, the evidence indicated that the Earth was coming out of a 10,000-year interglacial period, on the way to a new Ice Age. Some scientists thought that this might happen in perhaps hundreds or thousands of years, while others thought it might take only 100 years. A lecture at Scripps Institution of

Oceanography in La Jolla, Calif., by Prof. John Isaacs in 1972, for example, startled the entire staff by promoting the latter fast track.

The National Science Foundation and the National Academy of Sciences both began looking at the Ice Age concept, and beating the bushes to look for scientists who would research climate. The emphasis seemed to be not so much one of science, but of devising scenarios to explain how climate change might be very rapid—and might adversely and drastically affect human behavior, for example, forcing entire populations to move south.

To give you the flavor of this: At the time (1974), the disaster-is-coming atmosphere was so thick, that I submitted, tongue-in-cheek, a proposal to the National Science Foundation (NSF) asking funds to study the Polynesians. My alleged rationale was that it would be useful to look at a population, which, for some reason, possibly environmental, had packed up all its members and possessions, and traveled via canoe thousands of miles to set up a new civilization on a faraway island. I requested funds for a three-year project that would outfit a large sailing ship, fully equipped, including medical specialists, in order to sail to the less populated islands and try to find out from the present residents, what events prompted their ancestors to move. (The idea of the doctors and dentists, was to offer islanders some services in exchange for their history.)

To my great surprise, the NSF was ready to fund this proposal; the funders were crushed to find out it was a joke! The science funding agencies, in this period, also gave birth to computer climate modeling. That action buried the actual science of climate, based on study of the solar-astronomical cycles and their correlation with long-term climate changes.

It was then, in the early 1970s, that ideology, and not science, began to drive so-called climate science. If a disaster scenario for global cooling might promote the use of more fossil fuels, and hence more industrialization and more population, another scenario would have to be found—equally scary but more directly blamable on human activity. The driving force, it seemed, was to get people to blame science for environmental disasters, to use fewer resources, and to shrink the world population, particularly its brown, black, and yellow parts.

And so the climate science funding proliferated, climate modeling proliferated, global warming and "greenhouse effect" propaganda proliferated—and climate science, based on study of solar astronomical cycles, oceanography, geology, and so on, was relegated to the closet.

Enter the Greenhouse

That there is a "greenhouse effect" in the atmosphere has been known and studied for more than 100 years. That there are certain obvious gases that make up the "greenhouse" has also been known; gases such as carbon dioxide, methane, nitrous oxide, ozone, and water vapor. The residual "natural" greenhouse effect (without the supposed anthropogenic input in the last 150 years), has been sufficient in the past 12,000 years to raise the Earth's atmospheric temperature by about 15°C, mainly as a result of the presence of water vapor and carbon dioxide. Considering the temperature at the beginning of this rise (about 5°C), with glaciers extending across all of North America to Cairo, Illinois, and in northwestern Europe, that increase in temperature has been rather beneficial to the well-being of humankind—to say the least.

It was as early as 1896 when Svent Arrhenius, at the University of Oslo in Norway, wondered, to himself and his colleagues, whether or not the expanding use of fossil fuels would lead to a shift in climate by the increase in atmospheric carbon dioxide. Professor Arrhenius was bringing to the surface an issue first commented on decades earlier by Jean-Baptiste Fourier and John Tyndall, both significant scientists in those days.

It was just 60 years later when Svent's son, Gustav, convinced the director of Scripps Institution of Oceanography in La Jolla, Calif., Roger Revelle, that it was time to begin measuring regularly the atmospheric content of carbon dioxide. Revelle agreed and hired a young post-doc out of Cal Tech, Dave Keeling, to set up a CO_2 laboratory atop Mauna Loa, on the big island of Hawaii. At that height, it would be above the marine inversion layer and, therefore, represent a basic, "pristine," Earth atmosphere.

By 1970, Keeling had enough useful measurements that Revelle considered it safe to announce that CO_2 in the atmosphere was increasing. Furthermore, because there were yet no carbon-12/carbon-13 microchemical analyses, the assumption seemed logical that the increase was from CO_2 produced by the burning of fossil fuels.

By the early 1980s, other carbon dioxide measuring stations had been established, in Bermuda and Antarctica especially. Furthermore, it was becoming possible to obtain useful samples from aircraft and high-altitude balloons. By 1990, the increase, as measured by all stations, indicated that the CO_2 content of the Earth's atmosphere was about 23 percent higher that it had been in 1840. This 23 percent is an estimate, in reality, because in 1840 there were no reliable measurements of atmospheric CO_2.

Well, so a 23 percent increase in CO_2 isn't as reliable as we might wish it to be. It is an increase, though, and it must be the result of the burning of fossil fuels. What else could it be? So, the presumption was born and grew under the careful tutelage of the new, growing breed, the green "environmentalists." They, in turn, found kindred souls in the computer modelers who, finally, had computers with enough RAM memory and disk storage to carry enough input to make their predictions seem plausible.

As a result, a story began to emerge that seemed to be credible if we were to believe the "evidence." And, who among the proletariat had any reason to doubt what "scientists say" or what "researchers say"? As the story goes, and it is familiar to us all, the increasing amounts of CO_2, methane, ozone, nitrogen oxides and the family of freon compounds produced by man will enhance the "greenhouse." As a result, more Earth-reflected solar radiation than normal will be "trapped" in this intensified "greenhouse," in the form of heat, thus raising the mean temperature of the globe.

The consequences, so the story continues, will be dire. Sea levels will rise because of the melting of the polar ice, large regions of forests and farmland will be destroyed, increased evaporation will wipe out all irrigation systems, and the changes in weather patterns will lead to droughts, or floods, or worse.

During the last period the Earth was significantly warmer

then it is today, during the "climatic optimum," about 1200 to 1400, there were vineyards in England and in Greenland ("Vineland"). Even as late as 1800, oranges grew at Natchez, Miss., and the Sahel was a vast, grassy plain. Considering climate change through the past 700 years, one can hardly say that today's globe is warming.

Speculation on Top of Speculation

There was, and is, of course, a disagreement about the reaction to a warming atmosphere, if there were to be one. Certainly, goes one argument, a warming ocean would result in increased evaporation, thence clouds and precipitation. The greater than normal cloud cover would decrease incoming radiation, lowering temperatures at the Earth's surface (V. Ramanthan of Scripps has verified this point). The increased precipitation would enlarge the continental glaciers, in Antarctica and Greenland, thereby resulting in a falling, rather than a rising, sea level. The greater-than-normal rainfall would enhance the growth of vegetation, crops, and forests, decreasing, as a result, the area of arid regions and improving the food supply worldwide.

So, we have speculation on top of speculation. Answers can come only when we know better than we do now the interactions, the fluxes, and the transports in the entire environmental system of the Earth. And, that's what research is all about.

The modelers would have none of this concept, however. Especially after James Hansen, of NASA's Goddard Space Flight Center, appeared before a Congressional committee in the summer of 1988, during one of the hottest months on record, and declared that there was no denying it, "Global warming is here!" Considering the temperature in Washington, D.C., at the time, it was simple for everyone to agree. The panic was on!

To scientists in federal laboratories, institutions funded by federal agencies, to the non-governmental organization (NGO) environmental advocacies (Worldwatch, World Wildlife Fund, Sierra Club, Greenpeace, and so on), and to a number of international organizations seeking a *cause célèbre,* the announcement and the political acceptance promised a bonanza. New federal offices were created, such as the U.S. Office of Climate Change, operating in the National Academy of Sciences. New international groups were created, such as the International Geosphere-Biosphere Program.

The United Nations, where control is the operative word, quickly organized the United Nations Environmental Program (UNEP), with Dr. Noel Brown, a social scientist (now retired), as the Director. UNEP immediately initiated the Intergovernmental Panel on Climate Change (IPCC), funded through the World Meteorological Organization (WMO). In turn, WMO quickly formed the World Climate Research Program (WCRP). And the money flowed.

One of the first "products" of these claques was the preparation of a "treaty" to be signed by the world at an international "summit," so that the growing impact of humankind on the Earth's environment could be slowed (maybe stopped) to avoid the catastrophe unfolding from computer models. Humankind, especially those who lived the "good life" in the so-called Western world, were the unconscionable "bad guys" in this scenario, and they would bear the brunt of any controls. Those in the less affluent societies, who could not provide the resources to avert the "discernible human influence on the global climate," would be covered by funds from the "bad guys"—about $150 billion per year.

And so, the Rio Earth Summit took place in 1992, trumpeting the greed of the "Western populations"; and all but a handful of countries signed "treaties" giving the U.N. the authority to control those human activities that the models claimed were adversely impacting the global climate. Those nations that did not sign the treaty, include the United States, the former Soviet Union, China, India, and the European Community.

IPCC Sounds the Alarm

Before the Rio Summit took place, in the summer of 1992, it was necessary to have an "official" document of the effects to be experienced from the "human influence on the global climate." This document was dutifully produced by the IPCC in 1990, from a group of about 200 of the most "competent professionals" from member countries of the U.N.

Chaired by Dr. Bert Bolin, renowned meteorologist, this group included such other stalwarts as Sir John Houghton of the United Kingdom, Thomas Wigley from the U.S. National Oceanographic and Atmospheric Administration (NOAA), and a lot of other scientists of good repute. There were also a number of panel members who probably had clear conflicts of interest, such as Merylin Hedger, climate policy officer of the Worldwide Fund for Nature. Scientific truth could be expected from scientists as Bolin, Houghton, Wigley and the like. One might question the input from members who were environmental advocates and had, therefore, vested interests other than scientific truth.

Well, the 1990 IPCC report stated that in the past century (1) CO_2 had risen by more that 30 percent, (2) average temperatures worldwide had increased by 1.2° to 1.5° Celsius, and (3) sea level rose by 50 to 60 centimeters. Then they predicted that we could expect (1) CO_2 would grow by another 50 percent, (2) atmospheric temperatures would increase by 3° to 4° Celsius, and (3) sea level could rise up to six meters, as the polar icecaps melted with the global warming—all by the year 2050.

A good choice of timing: Who of these clowns would be around in 2050 to be faced with their predictions?

'Working Geophysical Scientists' Respond

I must say, also, that the "working geophysical scientists"—the oceanographers, the meteorologists, the atmospheric chemists and physicists, and the basic climatologists—were all caught by surprise by the vast publicity that spread through the media and popular press from what were clearly *speculations*—speculations that were publicized even though there was no suitable scientific research to support the claims. But, how was the the public to know that? Furthermore, it seemed that journalists, editors, and publishers, as well as the electronic media, had turned overnight from reporters into advocates.

Reputable scientists disagreed that an atmospheric crisis was at hand. Nils-Axel Morner, from Stockholm University, at a meeting of the American Association for the Advancement of Science in New York, scorned the prediction of rising sea levels. He noted that there was simply not enough water in mid-latitude glaciers to cause such a rise (of several meters),

Science was left by the wayside as scientists, journalists, non-governmental organizations, and political officials scrambled onto the greenhouse bandwagon.

and that a 4° Celsius increase in temperature (the modelers' claim for the year 2050) might result in sea level rising 4 inches. Morner got no play in *The New York Times* the next day, or elsewhere.

Robert Stewart, from Victoria University in Vancouver, British Columbia, had given a keynote address at the Joint Oceanographic Assembly, Acapulco, Mexico, in August 1988, on the conditions around the world that influence changes in sea level. Considering every possible factor, he noted that eustatic sea level had been rising at a rate no more than 1 millimeter per year for the past two centuries, and there were no natural or anthropogenic circumstances likely to change that rate for the next century.

K.O. Emery and David Aubrey, from the Woods Hole Oceanographic Institution, verified Stewart's analysis in their 1991 publication *(Sea Levels, Land Levels, and Tide Gauges,* Springer-Verlag), a *tour de force,* in which they analyzed every tide gauge location and its tidal curves worldwide for the century from 1880 to 1980. In those 100 years, eustatic sea level had risen 11 centimeters—about the rate at which juvenile water enters the Earth's ocean water cycle, at a snappy 1 millimeter per year.

Bob Balling, from Arizona State University, a world renowned and respected climatologist (who does not get invited to the IPCC) had the following to say at a 1994 meeting of Doctors for Disaster Preparedness in Tucson:

> From 1979 to 1990, and during the time of most rapid buildup in atmospheric concentrations of greenhouse gases, the satellite-based temperature measurements have shown a planetary warming of only 0.001°C (including data from 1991 and 1992 would lower this value because of the cooling effects from the aerosols produced by Mt. Pinatubo). Most of the numerical models of climate suggest that the warming (given the known increase in equivalent CO_2) should be of the order of 0.3°C over the same period of time. The satellite data indicate virtually no warming at all, and certainly do not support the claim of accelerated warming in recent decades.
>
> From the global evidence, along with mounds of hemispheric and regional evidence not covered here. . . I firmly believe that the observed changes in planetary temperature are not consistent with expected changes given the known increases in the atmospheric concentration of various greenhouse gases. Most of the observed warming occurred before the bulk of the greenhouse gases were added to the atmosphere (in the decades of the '20s and '30s). The amount of warming has been too low to be consistent with catastrophic predictions. Many other factors other than the rise in CO_2 concentration account for the trend and variations in planetary temperature. In addition, this warming has not occurred in the right places to be consistent with the models (for example, the Arctic region). Furthermore, most of the warming has occurred at night, which is not a greenhouse expectation.
>
> Very simply, the climate record over the last century, or decade, is not pointing in the direction of a greenhouse apocalypse.

These comments by Bob Balling were echoed by scientists around the world.

In addition, many climate scientists "jumped" on the computer models. The model problems of the 1980s, were, and still are today, that the models suffer from a bad case of holding too many things constant. Variations in sea-surface temperature, the effects of clouds, deep-ocean convection and circulation, and Lorenz's "butterfly effect," are either ignored, held constant, or even entered backwards. If clouds are entered, the assumption is that they will produce warming when, in fact, all satellite data indicate that clouds cool rather than heat the Earth.

Several reliable research scientists using and studying models, including Michael Schlesinger, from Oregon State Univer-

sity at Corvallis, pointed out that "You have every right to be skeptical [of today's models], but it is the best we can do [at this time]. Our ability to detect global warming is near zero." Mike was one of about two dozen who responded with similar caution. Several of them were in federal government laboratories; in NOAA and NASA, and who, after a few months of such reaction were heard from no more. And, as you might imagine, their responses never reached the popular media.

Scientists not under direct control of federal agencies, or dependent on federal funding, continued to provide and publish data that provided a contrary view to that of the IPCC, WMO, environmental NGOs, and federally "captured" scientists.

One of the more telling blows came from highly regarded scientists at the University of Oslo. After a detailed study of stable carbon isotope ratios of all carbon compunds that contribute CO_2 to the atmosphere, from 3,000-year old Antarctic ice cores, and evaluating Dave Keeling's data from Mauna Loa, and other Northern Hemisphere stations, Dr. T.V. Segalstad, from the University of Oslo, determined that

> At least 96 percent of the current atmospheric CO_2 comes from non-fossil fuel sources; that is, natural marine and juvenile [volcanic] sources. Hence for the atmosphere CO_2 budget, marine degassing and juvenile degassing (from volcanic eruptions) are far more important, and the burning of fossil-fuel and biogenic materials much less important, than hitherto assumed.

This statement is from a paper that Segalstad presented at the 1992 Chapman Conference in Hawaii, on "Climate and Volcanic Aerosols." Over the next two years, he and his colleagues at the University of Oslo continued their evaluation of the carbon isotope ratios on thousands of additional samples from the atmosphere and stratosphere around the world. Segalstad published an update in 1994, showing that the ratios did not change from those determined in 1992. By this time, even Dave Keeling, at Scripps and Mauna Loa, agreed that the major contributions to atmospheric CO_2 come from natural sources.

You can easily imagine the reactions of the environmental activists upon hearing that there is no global warming, that the activities of "humankind" have had no impact on the world's atmosphere or stratosphere, and that there is no scientific expectation that there ever will be an anthropogenic influence on our "universal climate." The environmentalists expressed "horror" at such "callous disregard of future generations," to quote one of them. They fought back by name-calling: Scientists who oppose global warming are simply "fringe scientists." They also fought back by demanding more regulations than have already been produced by local, national, and international bureaucracies. And, unimaginable as it might seem, the environmentalists fought back with personal threats on the lives, careers, and families of those of us who have scientific truth as our fundamental agenda.

I won't bore you with the details of the interplay between scientists and environmental advocates that took place between 1990 and the next IPCC report in 1995. None of the geophysical data, nor the publications, nor the discussions by working scientists seemed to have the least bit of impact on the IPCC/WMO/UNEP.

In the popular media, it was "no contest"! The "advocates" were the clear winners. In peer-reviewed scientific literature, however, the results of fine research were "blowing the advocates out of the saddle." Since 1992, I have personally perused more than 2,800 papers that contradict "global warming."*

IPCC Reports to the World, Aug.-Dec. 1995

The long-awaited report from the IPCC, that all of us knew would be greatly revised from that of 1990, was a "comedy of errors."

In April, three months before the report was scheduled to be released, members of the IPCC, and observers appointed by various nations, met in Maastricht, the Netherlands, to preview and comment on the draft report prepared by the "working staff" of the IPCC. (Of course the IPCC has a staff. Do you really think the "Great and Good" at the top do all their own research, reading, delving, analyzing, interpreting, and writing?)

The members were to have the draft some weeks before the meeting, and then break up into working groups to address the many chapters and items in the report. Not only did none of the members receive the draft document ahead of time, but no copies were ready for them when they arrived in Maastricht. Nevertheless, during the confusion of the first few days, the staff—whoever they are—issued a press report to the world's assembled press, titled "Conclusions reached by the IPCC's studies over the preceding three years." As you might expect, this release was seen by none of the milling, assembled members of the Panel.

Dr. Fred Seitz, former president of the U.S. National Academy of Sciences and former president of Rockefeller University, among other credits, and currently director of the Marshall Institute, was not only unhappy; he was furious. He returned to Washington and immediately sought audiences with the Secretary of State and the president of the National Academy of Sciences. The results of these meetings were letters of condemnation, censure, you name it, to U.N. Secretary General Boutros Boutros-Ghali, the United Nations Environment Programme, WMO, and Bert Bolin, Chairman of the IPCC. The news release was retracted. Were any of the IPCC staff fired for this activity? No.

The next IPCC meeting was in Boulder, Colorado, in 1995, during the XXIst General Assembly of the International Union of Geodesy and Geophysics, at which the "official" IPCC report was discussed in several sessions over 8 hours. The IPCC had, indeed, modified the predictions made in 1990. The most obvious, and conspicuous, was the change of the prediction date from 2050 to 2100.

IPCC's 1995 Modifications

Yes, CO_2 would continue to increase in response to the burning of fossil fuels, the report said. Interestingly, there was no mention of the data and results from the research at the University of Oslo, nor of the information regarding the introduction of CO_2 from the oceans. There was considerable space used to address the increasing methane in the atmosphere—failing to mention, however, the production of methane by volcanic eruptions, of which in this past decade there have been three times the number that occurred in the past 40 years.

It was declared that "recent years have been the warmest since 1960," and that "global mean temperatures have

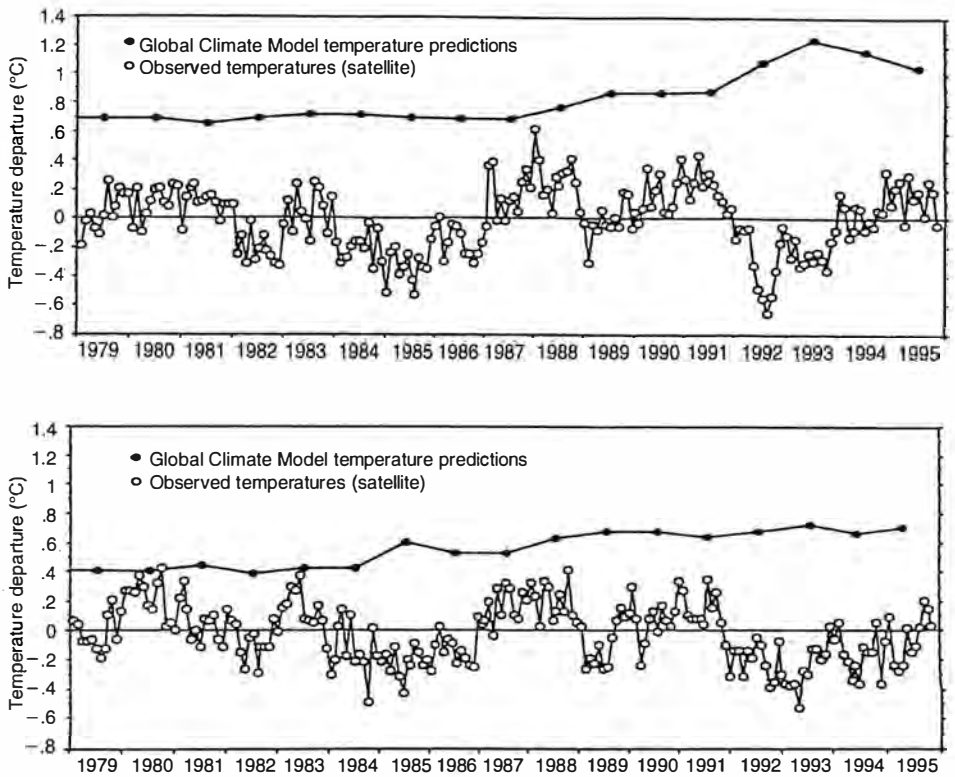


Figure 1
CLIMATE MODEL PREDICTIONS VS. SATELLITE MEASUREMENTS

Climate model predictions for temperature in the Northern and Southern hemispheres (solid black dots) are far higher than the actual satellite measurements. The observed warming is 0.5° C, while the models cited by the United Nations in 1992 predict warming between 1.3° and 2.3° C. In its 1995 report, the IPCC acknowledged that the earlier predictions were too high.

Source: Adapted from Patrick J. Michaels, testimony Nov. 16, 1995, before the House Committee on Science Subcommittee on Energy and Environment

increased by between 0.3 and 0.6° Celsius since the late 19th century." The IPCC did not note, however, that the years between 1920 and 1940 were the warmest of this century. It was interesting, too, that the century-long increase "certified" by the IPCC is almost precisely that measured by meteorologists, and analyzed and reported by Bob Balling. He, of course, was not mentioned, even though the report had a rather extensive bibliography.

For the "future," CO_2 would reach 500 ppmv, the report said—by the year 2100, I guess. They didn't really say. And, during that century-long period, atmospheric temperatures would rise by 1°C. One degree Celsius! *In other words, we're going through all of this for 1° Celsius.* Three-tenths of a degree is easily within the margin of error (for thermometers), and five-tenths of a degree is still dicey, because of the "heat island effect" of cities, which tends to artificially raise the average of temperatures measured.

As for sea levels: The report claimed that "global sea levels have risen by between 10 to 25 centimeters over the past century. [Ten yes, but 25, no way.] The increasing atmospheric temperature from 0.6°C (taking the highest) to 1.0°C will result in "sea levels rising by another 15 cm." Naturally, the IPCC report doesn't describe the cause of this rise. Were they simply to do some elementary-school math, taking the coefficient of expansion of water (sea or otherwise), and applying an atmospheric temperature increase of 0.4°C, then reckoning with the manner of thermal distribution through the ocean surface, they would have easily produced the answer that the additional heat would raise sea level by *0.03 millimeter by the year 2100*—a three-orders-of-magnitude miscalculation.

As for the temperature record: The accompanying illustrations show the following: Figure 1 compares 16 years of temperatures from U.S. satellites, as analyzed at Marshall Space Center in Huntsville, Ala., to the predictions of the climate modelers. Figure 2 is a graph produced by the staff of the "Great and Good" at WMO of global temperature anomalies from 1860, using 1951 to 1980 as the base. Notice the difference it would have made, had they used 1935 to 1965 as the base. Figure 3 is an extremely interesting graph of air temperature and sea surface temperatures from 1856 to 1987. This is from a joint study by people at the Massachusetts Institute of

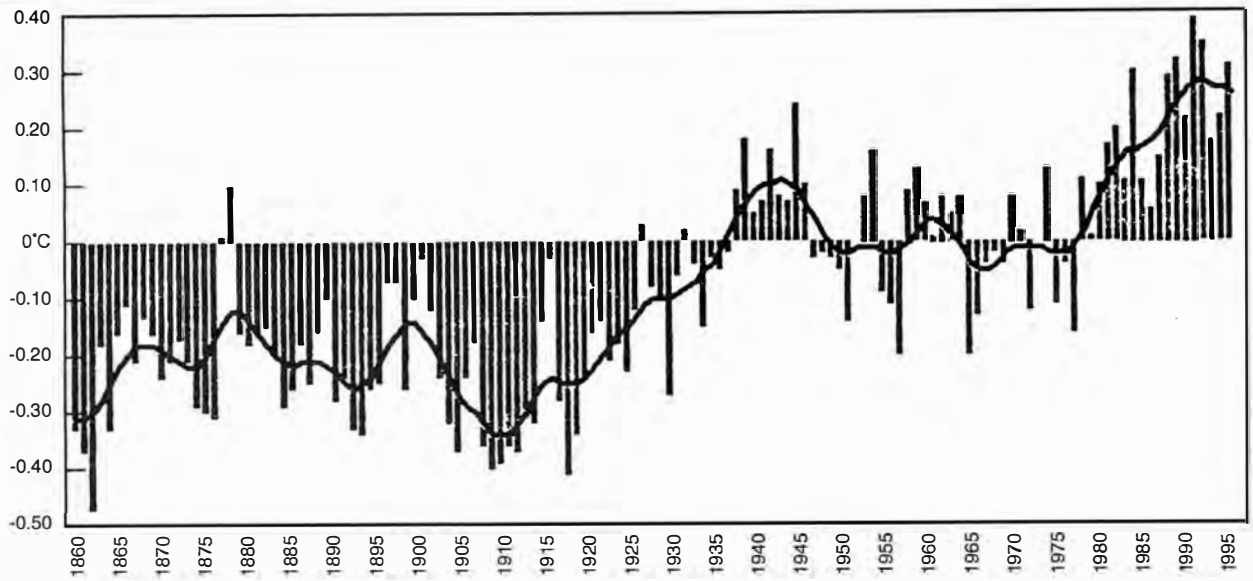


Figure 2
SEA SURFACE TEMPERATURE AND SURFACE GLOBAL TEMPERATURE ANOMALIES COMBINED (1860-1980)
Global land, air, and sea-surface temperature anomalies in °C are computed as departures from the 1951-1980 base-period means. The fitted curve is a 21-point binomial filter. This graph is updated from the one used in the 1992 IPCC report.

Source: Hadley Centre, Meteorological Office, U.K.

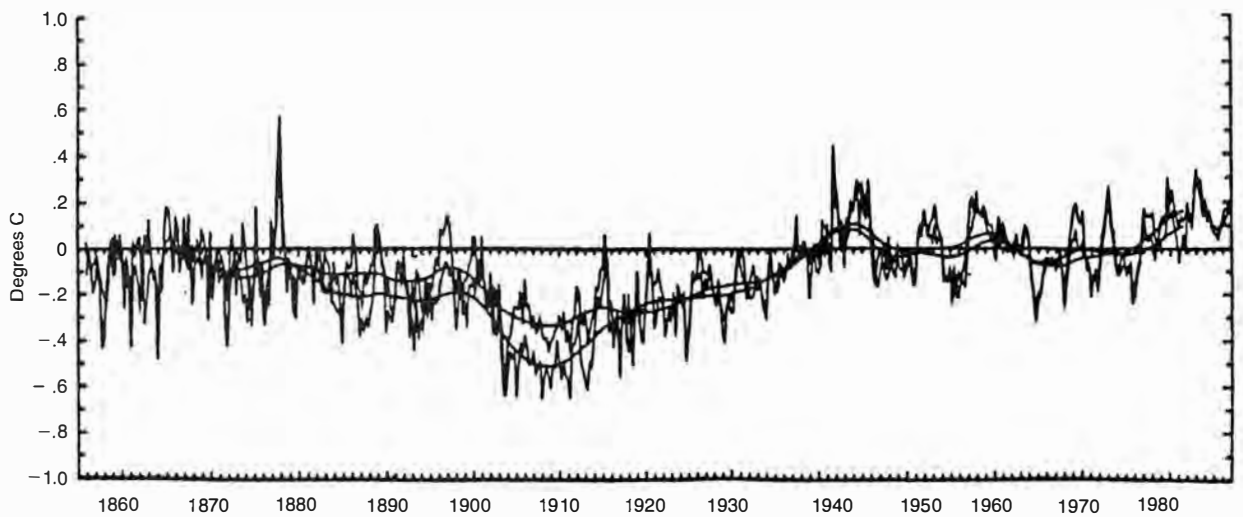
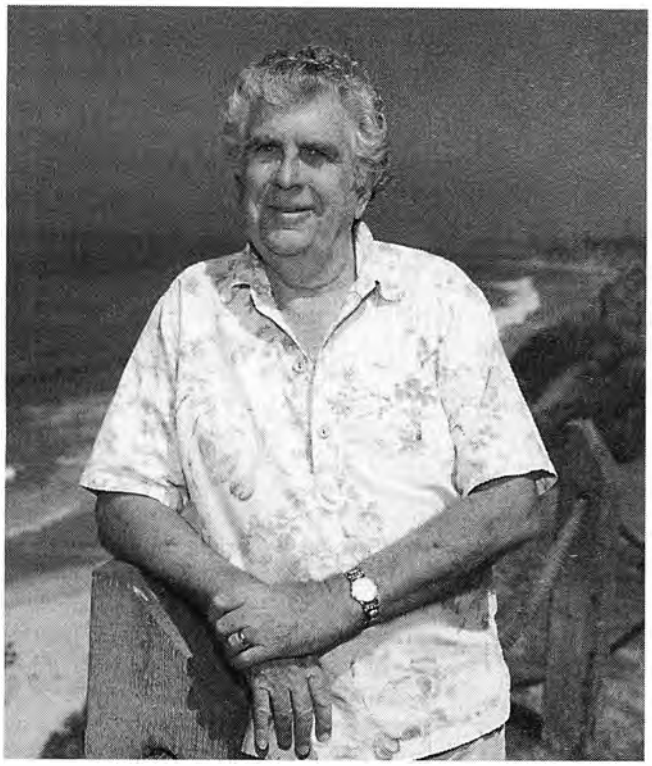


Figure 3
AIR AND SEA SURFACE TEMPERATURES (1856 TO 1987)
These data, taken from ships' logs over 130 years, indicate no change in sea surface temperatures. The higher line is water temperature; the lower line is air temperature.

The range in this graph and in Figure 2 is nearly the same; the graph in Figure 2 simply uses a larger scale than that of the seagoing data. The difference between the extremes of the data peaks in Figure 3 is 0.14°C. In Figure 2, the difference between the extremes is 0.08°C—in other words, nearly the same.

Source: Massachusetts Institute of Technology and the British Meteorological Office



The author looking out at the Pacific, near his home in California.

Technology (MIT) and the British Meteorological Office, taking the data from the logs of thousands of ships that sailed the world's oceans and seas in the 130 years in question. The researchers went to the effort to learn how water temperatures might be affected by winds blowing around the wooden and canvas buckets used to collect the water sample, and the influence of the ship on air temperatures, modifying the numbers by these results.

Everyone has agreed that the British/MIT graph indicates no change in sea-surface or marine air temperature in the 130 years since 1856. Notice, too, that the range in the WMO and the British/MIT graphs are nearly identical; the WMO simply uses a more exaggerated scale than that of the sea-going data.

Major *Faux Pas*

Up to this point, I've not elucidated any major *faux pas* in the IPCC report. Believe me, though, they made them: two wing-dingers, wowies, holy cows, you-got-to-be-kiddings, and you-clearly-were-absent-when-they-passed-out-brains.

The main advisory panel of the IPCC endorsed the conclusion that "the balance of evidence suggests that there is a discernible human influence on global climate." This misguided judgment created bitter arguments during a three-day meeting in Madrid in fall 1995, when "experts" from more than one country emphasized the "uncertain" nature of recent evidence pointing to human effects on climate.

The result of this discussion was to be a compromise in the language of the statement, but that did not happen. Despite the opposition of many signatory countries and their scientists, the leaders of IPCC published the "final version" using the phrase "discernible human influence," on the global climate. The unethical editorial changes were exposed and published by Dr. Fred Seitz, the premier American scientist in the field. Even when exposed, the IPCC leaders claimed it was their "right" to change scientific conclusions so that political leaders could better understand the report. Unbelievable!

To the world's geophysical community, these unethical practices and total lack of integrity by the leadership of the IPCC have been enough to reveal that their collective claims were—and are—fraudulent.

The most interesting aspect of this ridiculous *faux pas* is that the responsible panel of the IPCC produced no documentation—raw data or otherwise—for their claim.

Then came the boldly false statement, of greater interest to me and other oceanographers than to others. The IPCC wrote:

> It is clear that the oceans are warming significantly in response to the global warming of the atmosphere. Furthermore, this matches the evidence that coral reefs are dying.

I've already addressed the non-warming ocean to some extent, but let me add some additional documentation.

At meetings of the American Geophysical Union in 1992 (Hong Kong), 1993 (San Francisco), 1994 and 1995 (San Francisco), Warren B. White of Scripps, and six colleagues, presented a series of papers on the "Global Interannual/Interdecadal Variations in the Upper Ocean Thermal Structure." They had made careful examinations and analysis of more than 5,200,000 temperature-depth measurements between 30°S and 60°N in the oceans from 1979 to 1994. Both sea-surface temperatures and the upper ocean to a depth of 400 meters exhibited a *cooling* trend throughout the 1980s of about 0.1°C, followed by a similar warming through 1994. Although not a large change, the trends were clear and certain in all oceans, especially in the mid-latitudes.

In the tropics, the two extensive El Niños in the 1980s moderated the cooling tendency. By 1995, Warren had enough data, and had conducted sufficient analyses, to be convinced that the variations in both the Atlantic and Pacific followed closely the 11-year sunspot cycle.

Now for that blather about coral reefs: Richard Grigg, coral-reef expert of the University of Hawaii, has surveyed Pacific reefs and atolls multiple times in the past two decades. *There is no evidence of any reduction or detrimental modification in the growth of the corals on any Pacific or Indian ocean reef that can be attributed to warming waters.* Furthermore, from his colleagues, Grigg has learned of no such change in the reefs in any other tropical ocean or sea.

The IAPSO Data

At the August 1995 General Assembly of the International Association for the Physical Sciences of the Oceans, held in Hawaii, there were 14 symposia presented, 5 of which dealt with subjects related to climate scale variations in the oceans and marine atmosphere, in both time and space. These were (1) Large-Scale Ocean Circulation, (2) Decadal and Interdecadal Variations in the Oceans, (3) Carbon Dioxide in the Ocean, (4) Air-Sea-Ice Interactions and High Latitude Ocean Processes, and (5) Ocean-Atmosphere Coupling and the Tropical Ocean and Global Atmosphere. In those 5 symposia, about

450 oceanographers and atmospheric physicists/chemists gave papers based on research conducted in the past four years.

Without going into great detail, the "bottom lines" are as follows:

(1) *There is no warming trend in the oceans, and has not been in the past 50 years.* There are places in the ocean that get warmer than other locations for periods of time up to decades, but those waters then cool as other ocean areas warm. These periods are so close to the 11-year sunspot cycle that it is difficult not to consider a correlation. Yet, over all, there are no warming or cooling trends in any ocean, including the Southern Ocean near Antarctica.

(2) Special attention was paid to the Arctic Ocean, when teams from the United States, Canada, and Russia occupied stations that had been visited repeatedly since 1937. The results? *There is no warming trend in the Arctic, and has been none since 1937.* Indications by the Canadian team of warmer than normal water turned out to be an intrusion of water from the Atlantic. In the past 60 years, *the Arctic ice pack has neither retreated nor thinned.* These data are not controversial!

(3) *There is increasing evidence that the computer model calculations of the ocean's absorption of anthropogenic CO_2 may be seriously biased.* Furthermore, intermediate latitudes of the ocean are highly variable CO_2 sinks throughout the year, being disrupted by storms and mineralization of carbonates by biological processes. The ocean's summer warming, or warming by water-mass intrusions, or El Niños, makes the ocean a *source* of CO_2 rather than a sink, as is usually supposed. The consequence is that there is far more ocean-produced CO_2 in the atmosphere than hitherto considered.

(4) *There is a growing volume of evidence and, therefore, a rapidly growing suspicion, that an El Niño does not produce weather,* such as, "El Niño rains," "El Niño droughts," and so on. Quite to the contrary. It seems that the weather comes first, then comes the El Niño! This will cause a lot of heartburn among weather forecasters, and it also ruins the contention of the "global warmers," that much of the "warming" comes from El Niños.

(5) *It seems that the prime source of global weather (maybe even climate) lies in the tropics.* Throughout the 10 years of the international Tropical Ocean-Global Atmosphere program (TOGA), there was great evidence (a) for the basic, equatorial origin of tropical storms, such as hurricanes, typhoons, and cyclones; (b) that the equatorial ocean and atmosphere are more energetic than suspected; (c) that the Asian monsoons play significant roles in the formation of El Niños, droughts, and modifications in the ITCZ (Intertropical Convergence Zone); and (d) that El Niño characteristics in the Pacific and Indian oceans do not correlate, one with the other, in time and space.

Now, here is a scientific discovery that will have extraordinary consequences on global circulation models and the forecast models for weather systems!

(6) *There is a long way to go before we really understand all of the interactions, the vagaries, and products of weather and climate.* Furthermore, it is clear that mankind is at least an order of magnitude, in numbers, from becoming a "geophysical force" on Earth, if ever!

Were there any environmental groups, or advocates giving papers, or even in attendance at the Honolulu IAPSO Assembly? Need you ask?

Time to Get on with Real Science

So, despite the cries of Jim Hansen, Carl Sagan, Stephen Schneider, James Anderson, Susan Solomon, Rowland and Molina, Robert Redford, Barbra Streisand, Jimmy Carter, the Club of Rome, the United Nations Environmental Program, the 1992 Earth Summit in Rio, the Montreal Protocol, and Worldwatch, Greenpeace, World Wildlife Fund, Prince Philip, or even Al Gore, the human population of the Earth has not reached untenable numbers, has not become a geophysical force, and has not established practices nor products leading to "global warming!"

The evidence supporting the above six statements has become too voluminous to ignore. The "bottom line" of today is that the advocates of "global warming/ozone hole/There's no more room at the inn," have lost the game. Yet, they have so much invested in treaties, regulations, intra- and inter-governmental agencies, organizations, NGOs, prestigious positions, personal endorsements, and so on, that their efforts to blow true and selfless science out of the saddle must grow more and more pernicious by the day.

To the general populace, there may seem to be no battle at all—especially for those who read only the popular media, who are unfortunate enough to be in schools ruled by politically correct environmentalists, or who watch and believe only network news, PBS, the Discovery Channel, or the Captain Planet cartoons on CNN. But, there is a battle, and the real geophysical scientists around the world are rising to fight and intend to win—right over might, to coin a phrase.

I believe that the unabashed lies put out to the world by UNEP, IPCC, and WMO are a true injustice, a great crime, that is causing completely unwarranted anxieties for many people around the world. Officials in such international organizations are mouthing disinformation—information that is totally without merit of truth.

It is past time to bury these officials and their claque of supporters and get on with real science.

Robert E. Stevenson, an oceanography consultant based in Del Mar, California, trains the NASA astronauts in oceanography and marine meteorology. He was Secretary General of the International Association for the Physical Science of the Oceans from 1987-1995, and worked as an oceanographer for the U.S. Office of Naval Research for 20 years. He is the author of more than 100 articles and several books, including the most widely used textbook on the natural sciences.

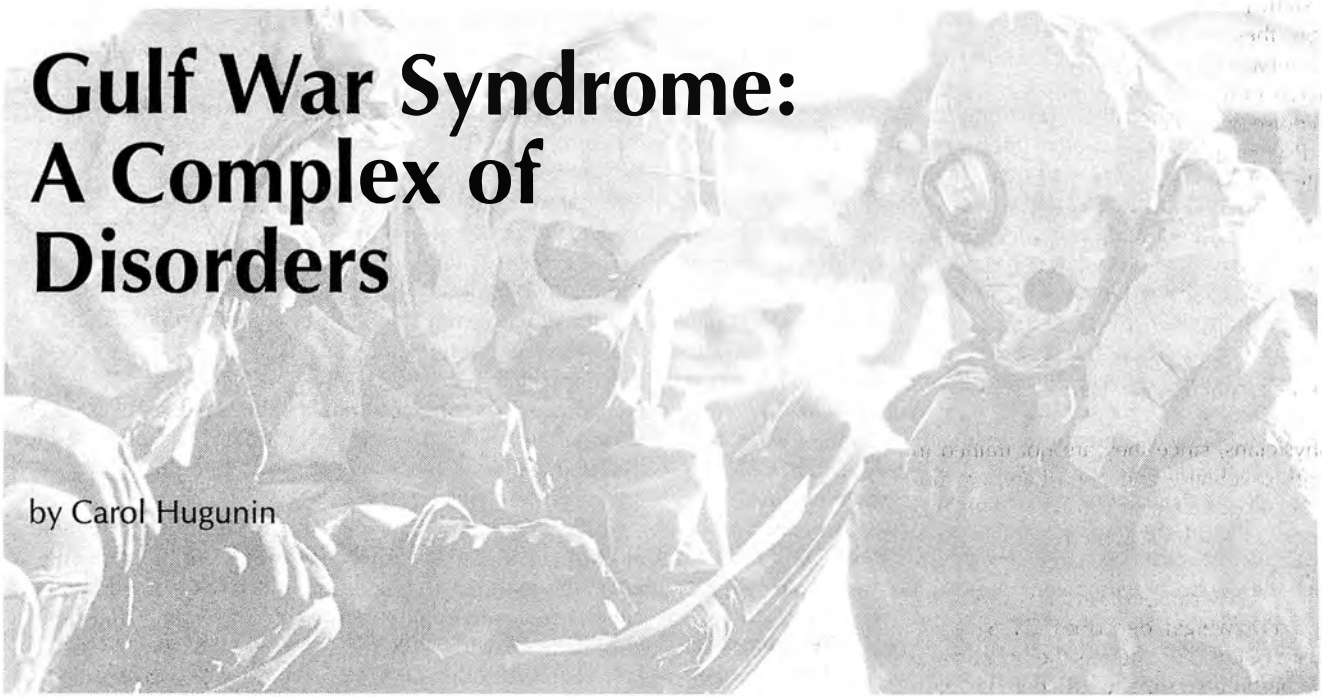
Notes

* This total does not include the published information in scientific journals that proves the hoax of CFCs and ozone depletion. These papers would double the 2,800 figure. I, along with others, are putting together suitable documentation of this rather unbelievable story of scientific quackery. In the meantime, we can only deplore the awarding of Nobel prizes to the three leading contributors, and the arrival of the federal deadline in the United States for ceasing the production, distribution, and use of all of the CFC species. The accompanying hazards this ban on CFCs has introduced to aircraft operations, air conditioning, medical practices, and agriculture, because of a U.S. regulation based on a pure hoax, begins to devastate all.

I must add, too, that the Montreal Protocol "group" which met first in London in 1990, has become, as you might imagine, a "permanent group." At its December 1995 meeting in Vienna, a large number of objections were raised to the basis for the disappearance of CFCs; noted the economic hardships such losses would place on all developing countries; and heard requests from several countries, notably those of the former Soviet Union, to delay the deadline of a CFC phaseout from 2001 to a later date. As one delegate from China remarked, "Perhaps to 3001."

Gulf War Syndrome: A Complex of Disorders

by Carol Hugunin



U.S. Army

Most medical doctors have concluded that these suits and masks were absolutely vital protection during the Gulf War, based on the fact that the French forces, who were rigorous about donning chemical protective suits whenever alarms went off, have had virtually no GWS problem in returning troops. Unfortunately, in many cases, U.S. troops were encouraged to ignore chemical alarms and not suit up. Here U.S. army troops are shown in full gear in Saudi Arabia during the war.

Under pressure from veterans' groups and testimony presented at congressional hearings, the official view of federal government agencies that Gulf War Syndrome (GWS) is merely a psychosomatic problem is beginning to give way.

The Department of Defense, for example, recently notified more than 20,000 troops that they *may* have been exposed to chemical weapons during the destruction of weapons at the Kamisiyah arms depot in southern Iraq. The action at Kamisiyah occurred in March 1991, but the Pentagon did not acknowledge that the troops had suffered exposures until late October 1996—a belated and grudging acknowledgment.

An estimated 60,000 veterans, out of a total combat force of 700,000, have developed a highly debilitating medical condition as a result of service in the 1991 Gulf War, according to Vic Sylvester, president of Desert Storm Association in Odessa, Texas. These veterans have a fairly consistent set of symptoms, including chronic fatigue, achy joints, blurred vision, sensitivity to bright lights, memory loss, sleep problems, mood swings beyond the normal range, headaches, rashes, and so on. This set of symptoms is now commonly referred to either as Gulf War Syndrome (GWS) or Gulf War Disorders (GWD). Sylvester's estimate includes only those veterans who have become so debilitated that they are either totally disabled, or able to work only a light job, by sleeping the remainder of the day.

Many government agencies, especially those associated with the Department of Defense and the Veterans Administration, had attempted to dismiss GWS as a psychosomatic problem generated by combat stress, apparently because it does not appear to be a simple, single-cause disorder. This may be a convenient way to avoid the expense of competent diagnosis and treatment—particularly when thousands of veterans are involved. Nonetheless, pressure from veterans' groups, as well as the Presidential Advisory Committee on Gulf War Veterans' Illnesses, and congressional hearings on GWS, have begun to force another view of the problem.

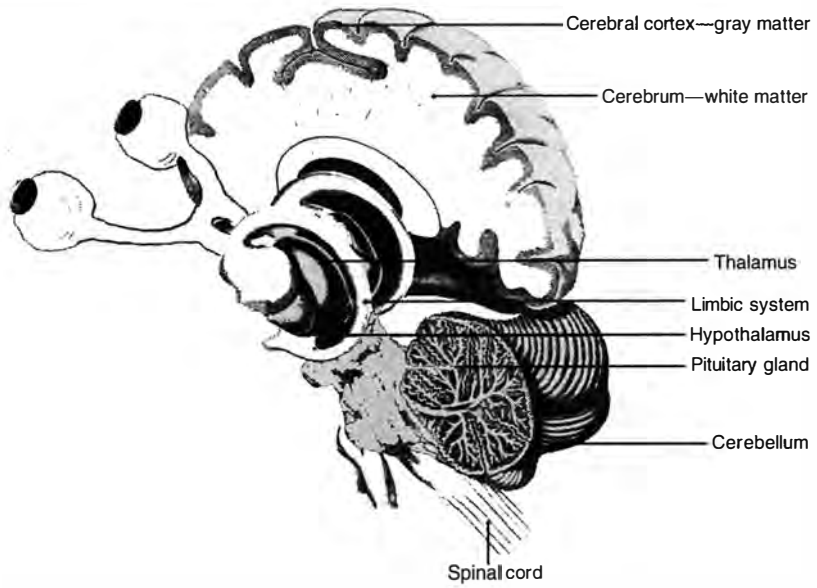
A Complex of Disorders

At a subcommittee hearing of the House Committee on Government Reform and Oversight on Sept. 19, 1996, William Baumzweiger, M.D., a psychiatrist and neurologist working at the Wadsworth Veterans Administration facility in Los Angeles, gave fascinating testimony on GWS. Baumzweiger says that GWS involves a whole family of related disorders, in which parts of the central nervous system malfunction, and become very easily irritated, because of encephalitis, inflammation of the central nervous system. The encephalitis, he says, is caused by an interaction in which chemical exposures allow proliferation of immune-suppressing infectious agents.

Ironically, this Veterans Administration psychiatrist, an expert in *psychosomatic* medicine, is identifying GWS as a *physical* disorder of the limbic system and brain stem. The limbic system, a part of the central nervous system, is a delocalized system that governs emotions, behavior, the olfactory system, and the autonomic system, which regulates

bodily functions that are not governed consciously. Because in GWS the limbic system is subject to chronic inflammation, these veterans experience changes in nerve cell functions, and heightened nerve irritability, especially in response to noise or sunlight.

Psychiatry and neurology took separate paths beginning in 1937, and, as a result, Baumzweiger says, the relationship between the mind and body is now very seldom studied: "The splitting of neurology from psychiatry, which used to be a unitary discipline, neuropsychiatry, has left a critical hole in our medical understanding. Unfortunately, Gulf War Syndrome falls into that hole." Most physicians, since they are not trained in *both* psychiatry and neurology, are unable to detect a physiological disturbance, like GWS, which involves neuropsychiatric medicine, he says.



SCHEMATIC OF THE LIMBIC SYSTEM

The limbic system consists of a pair of roughly comma-shaped structures which help govern emotions, behavior, and the olfactory system. It includes the autonomic system, which regulates bodily functions that are not governed consciously. The autonomic system also involves the brain stem, which connects the brain and the spinal cord.

A Neuropsychiatric Disease

Baumzweiger describes GWS as follows: "Clinically, there is the appearance of multiple simultaneous memory, motor, emotional, and other deficits, which are characteristic of dysfunction in specific limbic system and brainstem components. The limbic system is the only part of the central nervous system in which these functions are all to be found 'in the same place.' Therefore, using classical neurological principles, we can localize GWS to the limbic system and brainstem."

Locating the nature of the problem, and the interactions that are causing it, enables Baumzweiger to begin to develop successful treatments to contain—and perhaps to some limited degree, to reverse—damage caused by GWS.

He points out that since the limbic system involves emotions and behavior, it is quite easy for many physicians, with their more limited training, to confuse a physiological limbic disturbance with psychosomatic problems.

GWS is very similar, clinically, to organophosphate-induced delayed neurotoxicity in civilians exposed to cumulative overdoses of organophosphate pesticides, which generate a *delayed* toxic effect in the nervous system, according to Baumzweiger's testimony. Organophosphates—for example, from exposure to low doses of nerve gases like Sarin—can trigger a proliferation of immune-suppressing viruses inside the central nervous system. Some of the herpes virus family, including the very nasty Human Herpes Virus 6 (HHV-6), are known to be capable of reactivation from a state of dormancy by organophosphates.

"The risks of organophosphate neurotoxin were greatly potentiated by the massive amounts of crude oil products in the Gulf during the war, making scientific estimates of the risk inaccurate," Baumzweiger testified. "There is experimental evidence that organophosphates can be potentiated by hexane, which is a hydrocarbon fragment found in great abundance in crude oil. Obviously, there was in the area plentiful crude oil from oil fires and wartime activities. The crude oil in the environment could have trapped and potentiated the Sarin and other organophosphates, making them more dangerous at low doses."

HHV-6 is an exceedingly nasty virus in its active reproducing phase, which is commonly encountered when a child is first exposed to the virus in the first few years of his life. Fortunately, in most adults, it is kept completely dormant by a healthy immune system. Baumzweiger thinks that other viruses, and even other, nonviral infectious agents, might also be involved, including possibly those contracted from live vaccinations given to soldiers prior to their deployment, or infectious agents soldiers were exposed to during a very dirty war. Whatever the exact combination of infectious agents, the net effect on the central nervous system was inflammation: brainstem and limbic system encephalitis.

"They [the Veterans Administration] may fire the whole department, just to get rid of me. They do not care about these veterans. They are more interested in issues of control, in their ability to dictate what is true and not true."

Unfortunately, Baumzweiger says, the damage done by organophosphates does not stop in the nervous system; the organophosphates also target lymphocytes, a key component in the immune system. This generates a double whammy: impaired central nervous system functions and impaired immune system functions, leading to additional infections and susceptibility to cancers.

The Veterans Administration would

prefer to make Baumzweiger's analysis go away, so it does not have to deal with it. Baumzweiger told this author: "They [the Veterans Administration] may fire the whole department, just to get rid of me. They do not care about these veterans. They are more interested in issues of control, in their ability to dictate what is true and not true."

Complex Interactions

Baumzweiger's thesis may be difficult for laymen to follow, but this complexity characterizes most chronic diseases and degenerative diseases. These are not simple cases of hitting billiard ball x with ball y, causing a simple mechanistic reaction. Such diseases are not curable by taking a single medication, or by eliminating the presence of a single infectious agent. And, in fact, because they involve complex interactions, they generally produce a family of related disorders, and each patient has a slightly different combination of symptoms. This means that considerable clinical skill and intelligence is required on the part of the physician in treating them. This is real medicine.

Another example of the complexity of the degenerative diseases facing medicine today is cancer, a huge family of related disorders with a similar kind of non-simplistic interactive causality. But, in the era of Health Maintenance Organization (HMO) medicine, in which patients are hustled through a business-oriented process for the sake of profit, it is no longer the kind of medicine that most physicians have the luxury of practicing.[1]

As HMOs increasingly dictate what doctors are permitted to do, physicians have been reduced to being medical computer specialists, plugging a list of symptoms into the computer, and then prescribing the regime of drugs the computer spits out. Because that approach fails to deal with the interacting causes of the problem, it tends to bury the symptoms with mood-altering drugs and pain killers—many of which are highly addictive—all in the name of "holding down medical costs."

In this context, GWS sufferers are the victims of a deliberate financial policy of collapsing medical infrastructure in both the civilian and military realms. Hearings held by the Presidential Advisory Committee on Gulf War Illnesses have documented cases in which veterans have been locked up in Veterans Administration psychiatric wards, and pumped full of Prozac, methadone, heroin, and similar drugs, as a cheap fix, instead of seeking a real solution to the problem.[2]

U.S. Army

Hexane, ever present in the smoke from oil well fires during the war, makes it possible for low concentrations of organophosphates to reactivate viruses like HHV-6, according to the testimony of Dr. Baumzweiger. Here, burning oil fields during the war.

The combination of the inability of veterans with GWS to work, and the denial, in most cases, of Veteran's compensation, means that the families of many veterans with GWS have fallen apart. According to Vic Sylvester, many veterans and their families have been forced onto welfare and food stamps, their children are often sent to foster homes, and divorce rates have climbed.

Thus far, among government agencies, only the Presidential Advisory Committee and the congressional hearings have been very critical of the Defense Department and the Veterans Administration for their lack of serious treatment of GWS. The Committee has issued one interim report, in addition to conducting numerous hearings.[3]

The Future Cost of Failure

Failure to take GWS seriously is undermining our troops' confidence in their leadership, as well as in the military's system of chemical weapons detection and protection. It is also detrimental to future war-fighting capacity: Many of the affected veterans may be treatable now as they begin to develop GWS, and could then serve in the future. If left untreated, however, they will deteriorate to the point that they are neither able to serve in the military or work in the civilian realm. It is also a health hazard for the civilian population, as some veterans appear to have passed infectious diseases associated with GWS—including difficult to treat parasitic diseases—on to spouses and children. And, Dr. Baumzweiger warns, failure to develop a rigorous, well-funded effort to study and treat GWS could have another future cost, since there are stockpiles of nerve gases in this country which may develop leaks as their containment systems age.

Can we afford the full price in the future, of skimping on these medical costs today?

Notes

1. For extensive documentation of the takedown of medical infrastructure under managed health care, see a series of articles in the report "Managed Health Care Is a Crime against Humanity," *Executive Intelligence Review*, Oct. 25, 1996, pp. 20-36.
2. For a more extensive treatment, see "Gulf War Syndrome: Deadly Legacy of George Bush's War," by Carol Hugunin, *Executive Intelligence Review*, Sept. 13, 1996, pp. 48-57.
3. This report is available upon written request from the Presidential Advisory Committee, 1411 K Street, NW, Suite 1000, Washington, D.C., Attention: Gary Caruso, (202) 761-0066, fax (202) 761-0310. However, the PAC is mandated only through the end of 1996. Requests must specify whether computer disk or paper copy text is desired. PAC expects to issue an additional report by the end of 1996.

   Congressional testimony is available by writing Christopher Shays, Chairman, Subcommittee on Human Resources and Intergovernmental Relations, House Committee on Government Reform and Oversight, Room B 372, Rayburn Building, Washington, D.C., 20515, Attention: Robert Newman, (202) 225-2548, fax (202) 225-2382.

HAARP Builds New Instrument For Ionospheric Research

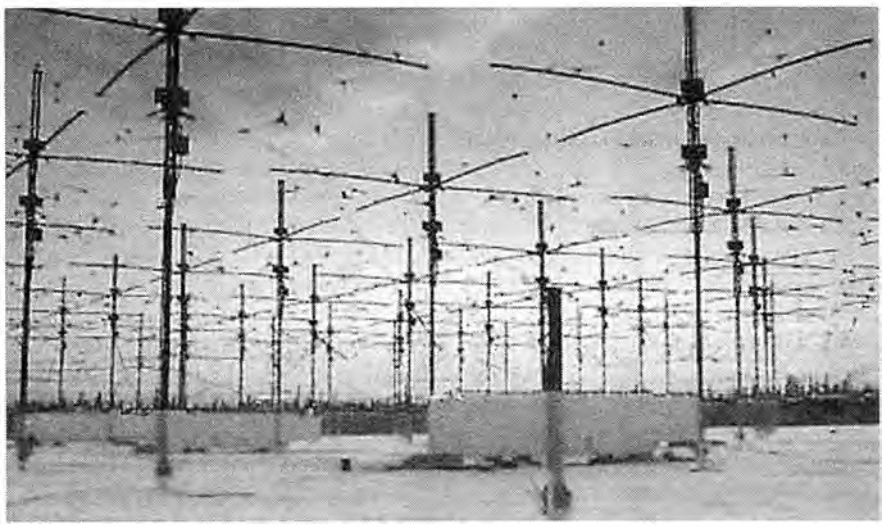
by Mark Wilsey

A new instrument for studying the upper atmosphere is under construction in Alaska. Called the Ionospheric Research Instrument (IRI), it is being built by the High-frequency Active Auroral Research Program (HAARP) run jointly by the U.S. Navy and Air Force. IRI will broadcast high-frequency (HF) radiowaves into the ionosphere and study the effects. The knowledge gained will help lead to a better understanding of that portion of the Earth's upper atmosphere, 60 to 200 miles in altitude, and its interaction with the space environment. It may also lead to a new means of communication, for example with submarines, or remote sensing of underground structures.

HAARP is a joint project of the Office of Naval Research and the Air Force Phillips Laboratory, with contributions from a dozen universities and research organizations. It's Ionospheric Research Instrument is being built near Gakona, Alaska, about 170 miles northeast of Anchorage, on a site originally purchased by the Department of Defense to be used for a radar base which was never built. Scheduled to be completed in 2002, the total cost of the HAARP facility is estimated to be about $160 million.

Created and sustained by the Sun, the ionosphere is produced when solar radiation strikes the upper region of Earth's atmosphere and knocks electrons off the atoms there, producing ions and free electrons. Thirty years ago, scientists began using HF radiowaves to probe the ionosphere. The energy from the radiowaves is deposited in the electrons, and increases their temperature.

Research in this area is referred to as atmosphere-heating experimentation. These are active experiments in the sense that it is the response of the ionosphere to the action of the experimenter, in this case propagation of radiowaves, that is observed. The facilities where these experiments are conducted are sometimes referred to as "heaters." One of the U.S. heater facilities is located at the Arecibo radio observatory in Puerto Rico. Another, the High-Power Auroral Stimulation (HIPAS) observatory is operated by the University of California—Los Angeles, near Fairbanks, Alaska. The Europeans and Russians also have heating facilities in the Arctic region.



Naval Research Laboratory

The IRI antenna array will consist of 180 towers and will be capable of broadcasting a radio beam of 3.6 megawatts. Currently, 48 towers have been completed, as shown here.

There are unique properties of the ionosphere which can only be studied at high latitudes. However, HIPAS does not have the flexibility and versatility of a modern heater facility. It uses the antenna array and transmitters of the world's first heating facility in Platteville, Colo., in the 1960s. The HAARP facility is to be a state-of-the-art, world-class research center, giving U.S. scientists greater opportunities to study the ionosphere.

A Fully Phased Array

HAARP's IRI will consist of 180 antenna towers covering about 33 acres. The 72-foot towers are to be spaced 80 feet apart and arranged in a 12 by 15 grid. Each tower will have two pairs of crossed dipole antennae; one pair for the low-band radio transmission (2.8 to 7 megahertz, MHz), the other for the high band (7 to 10 MHz). The antennae in each pair are oriented with one pointing north-south and the other east-west.

Each antenna pair will have its own 10-kilowatt transmitter, giving the total array 3,600 kilowatts (3.6 megawatts) for transmission. The power for the IRI will come from four 2.5-megawatt diesel-driven generators. The IRI, with all 180 towers, is expected to be completed in 1999. At present, 48 of the towers have been completed, and 18 of them are connected to transmitters.

The IRI is designed to be a fully phased array, meaning that the ampli-

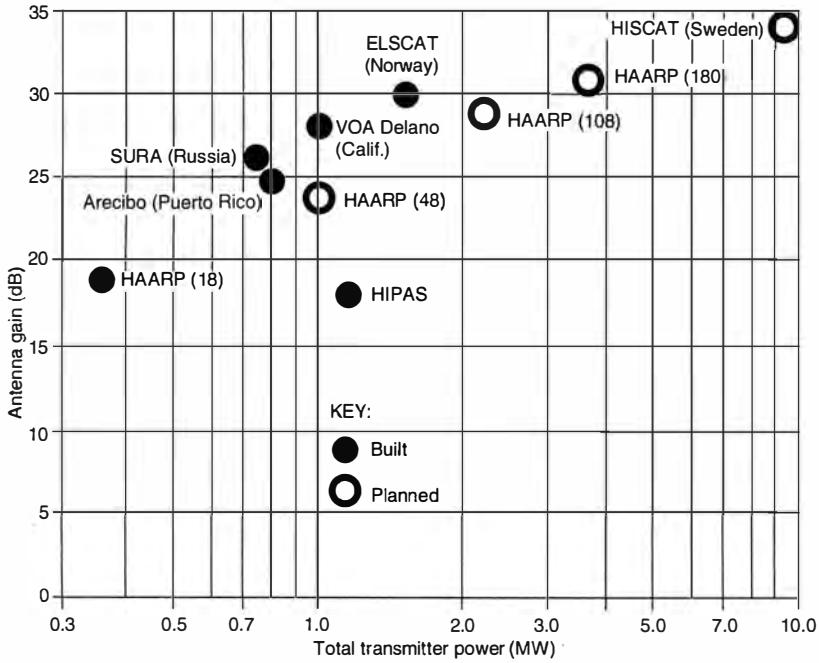


Figure 1
HIGH POWER TRANSMITTERS OPERATING AT HIGH FREQUENCY
The HAARP Ionospheric Research Instrument (IRI) is a high-power, high-frequency transmitter. There are several other such transmitters, some for ionospheric research and others for international broadcasts, such as those of Voice of America. A few of these facilities are compared here. The four points marked HAARP represent successive stages in its construction, from an 18-tower prototype to the full-scale 180 tower system.

Naval Research Laboratory

tude and phase of the signal from each of the transmitters can be independently controlled. Among research heaters, this will be a unique feature, giving scientists a great deal of flexibility, both in the type of radio beam they can generate, and in its direction. Not only can the beam be focussed into the ionosphere at altitudes ranging from 60 to 200 miles, but it can also be steered anywhere within 30 degrees of the zenith. The beam width itself can be as narrow as 5 degrees. In general, the higher the frequency and power, the finer the control of direction and beam width.

If HAARP's IRI is found to be interfering with another radio transmission, the phased array design allows amplitude and phase to be adjusted to create a null in the direction of the source and thus eliminate the interference.

John Heckscher of HAARP Program Management at Phillips Laboratory explains that IRI is designed to direct the energy upwards, not out to the sides or down to the ground. A measure of IRI's effectiveness in directing its beam is the comparison with a non-directional antenna. This measure is called "antenna gain," and is expressed in decibels, dB, a logarithmic scale on which each 10 points represents a 10-fold increase. At full power, IRI is expected to have an antenna gain of about 30 dB. In other words, IRI is designed to be a thousand times more effective in directing its beam than a non-directional antenna.[1]

Tracking Electrons

A second major piece of hardware associated with IRI will be an incoherent scatter radar, ISR. While normal radar senses the signal reflected from large objects, ISR measures the radar signal that is scattered by a group of electrons.

The IRI will first energize the charged particles---electrons and ions—in a small region of the ionosphere, perhaps a dozen miles in diameter. Only the charged particles interact with the HF radio signal. To measure the effects, the incoherent scatter radar will then send out a radar pulse, and from the signal returned, the number of electrons present can be deduced, and a number density profile constructed. The frequency of the return signal will be broadened by the thermal motion of the electrons. This broadening will indicate the electrons' temperature structure. And because the electrons are part of the atmosphere, the motion caused by atmospheric winds can be measured by the doppler shift of the signal.

Because there is a certain balance between ions and electrons, the effect of ion motion on electron motion can be determined if the measurements are sensitive enough, and the ion temperatures can then be determined.

Increases in ion temperature caused by heating effects are too small to be measured directly, and are thought to be on the order of a degree or less. Electrons may be heated by 2,000 K, but an ion is several thousand times heavier than an electron, so the same amount of energy translates into a much smaller temperature rise for the ion.

Typically, the beam is turned on only for a short time, depending on the experiment. The heating effects in the ionosphere dissipate quickly, on the order of minutes, once the beam is shut off. The atmospheric component primarily affected by the HF radiowaves is the electrons, and the effects on the rest of the atmosphere are negligible.

Dr. Louis Duncan at the University of Tulsa in Oklahoma, who studies the ionosphere and space plasmas, explains that at mid-ionospheric heights, the ratio of neutral atoms to electrons is about a million to one. These electrons are like ping-pong balls rattling around among millions of bowling balls. "The [electrons'] ability to perturb the neutral atmosphere is insignificant to the point of being unmeasurable," Duncan says. He points out that there have never been any detected changes in the neutral atmosphere from heating experiments at any of these facilities worldwide.

HAARP will also have a host of other instruments to study the upper atmosphere. There will be telescopes to detect what faint optical emissions there may be from the heated region. A LIDAR—a radar-like system using laser light—will detect minute atmospheric concentrations of such things as water vapor, solid particulates, and ozone. A riometer (relative ionospheric opacity meter) will

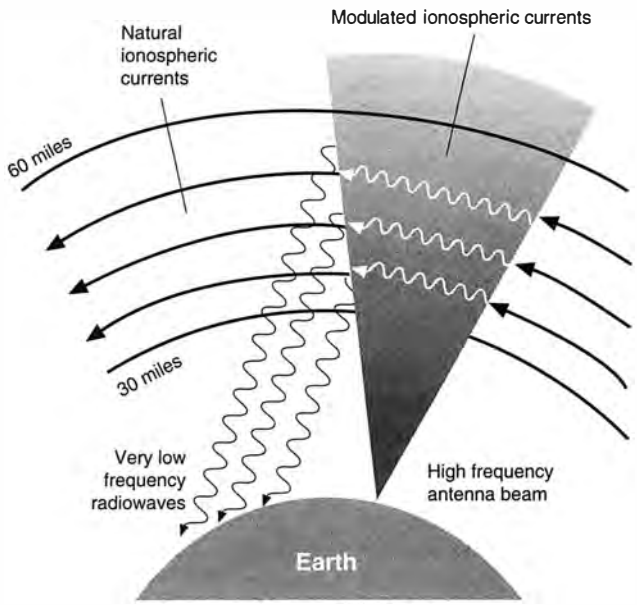


Figure 2
IONOSPHERIC HEATING GEOMETRY

A beam of high-frequency radiowaves is used to heat a portion of the ionosphere. At high latitudes, naturally occurring ionospheric currents can be modified by the heating effects of the radio beam, causing them to re-radiate low frequency radiowaves that may be useful for communications with submarines and remote sensing.

ARL/Penn State

sense changes in ionospheric absorption of celestial background electromagnetic radiation, which gives a measure of how churned up the ionosphere is because of solar activity. Also, magnetometers will measure the Earth's magnetic field and its variations.

Because the IRI beam may interfere with the electronic equipment in aircraft, HAARP will also operate a radar to ensure that the facilities will never be turned on if an airplane is in the area. This safety measure is also followed at HIPAS.

Laboratory without Walls

Physicist Umran Inan of Stanford University points out that lightning discharges can also trigger the types of heating effects in the ionosphere that the IRI will generate. Part of Inan's research includes studying how radiowaves reflected off the ionosphere are modified by changes there caused by lightning discharges. However, lightning occurs at random places at random times, so it is difficult to build an experiment around it. In contrast, Inan explains, these heating facilities create effects that occur at chosen times and places, making it possible to perform controlled experiments.

It is possible, and indeed likely, that some of the work at the HAARP facility will have less to do with understanding the atmosphere and more to do with understanding basic physics, plasma physics in particular.

Plasma physics research in the laboratory often requires large vacuum chambers in which an ionized medium is created. However, one always runs into effects at the walls that can make the data more difficult to interpret.

"The ionosphere is a natural plasma laboratory," Inan notes. "It is an unbounded medium, so you can understand the effects of the heating and radiowaves without the confusion that is brought about by these walls."

HAARP research could yield insights into such areas as laser fusion and solar physics.

Antenna in the Sky

One of the reasons for studying the ionosphere near the Arctic region is that interesting physical phenomena take place there. Energetic particles from the Sun stream toward the Earth. Some particles are caught in the Earth's magnetic field and flow down to the poles. It is this stream of particles, impinging on the upper atmosphere, which creates the auroras, a phenomenon that continues to fascinate scientists. Large electric currents in the ionosphere, called the auroral electrojet, are also created by this stream of particles.

Part of HAARP's mission is to test the feasibility of using these ionospheric currents as a means of broadcasting low-frequency radiowaves, which could be used for communications or remote sensing.

The idea is that when HF radiowaves from IRI heat a portion of the ionosphere, the change in temperature affects the collision rate of the electrons. The collision rate is essentially analogous to the resistance of a wire. By modulating the "resistance" of the ionosphere, one in turn modulates the current in the auroral electrojet, in effect switching the current on and off. Therefore, if the experimenter modulates the HF signal with some lower frequency, such as one in the ELF (extremely low frequency) or VLF (very low frequency) range, these ionospheric currents will re-radiate at the ELF or VLF modulation frequency. A "broadcast antenna" hundreds of miles long is created in the ionosphere by this means.

It is hoped that this method of producing low-frequency radiowaves could be used to communicate with submarines while they are submerged. Radiowaves travelling through water attenuate in rough proportion to their frequency. To reach submerged submarines, the ELF range is necessary, requiring a correspondingly long transmitting antenna. The Navy operates a long ground-based antenna in Wisconsin, but there are difficulties in building, maintaining, and securing an antenna on the ground that is tens of kilometers long. If HAARP can successfully demonstrate the use of ionospheric currents for low-frequency radio communications, it may prove to be an attractive alternative.

These low frequency radiowaves also penetrate the Earth to a significant depth, so they may be useful for sensing irregularities underground. By analyzing the waves as they are reflected back from Earth's interior, it may be possible to "see" geological features like faults or mineral deposits. The Army may be able

to use this technique to discern underground bunkers or missile silos.

Geologists and oil exploration experts have actually been using a similar technique, called magnetotelluric surveying, for many years. They use the normal background noise generated by lightning and fluctuations in the Earth's magnetic field as the energy source for their readings. But it takes a long time—on the order of days or weeks—to obtain useful data. Quick results could be obtained, if the desired frequency were known, by using the HF radio technique to induce the ionospheric current to radiate at that frequency.

The Limits of Power

Although IRI's radio beam will be quite powerful, the variations it will produce in the ionosphere are hundreds of times less than the natural variations in intensity of the solar radiation which creates the ionosphere. Solar radiation at the top of the atmosphere is about 1,400 watts per square meter, while the greatest power densities that IRI will achieve in the upper atmosphere are on the order of a few hundredths of a watt per square meter. At periods of high solar activity, when the ionosphere is at its most turbulent, IRI effects will be washed out.

IRI will be able to create small local variations in the Earth's magnetic field, roughly equal to the continuous, random, low-level variations that occur naturally. However, during a Sun-induced geomagnetic storm these variations increase 10,000-fold or more, which will again completely overwhelm any effect from IRI. The Earth's static magnetic field is itself 10 million times stronger than the magnetic variations IRI is expected to produce.

By spacing the towers over 33 acres, the intensity of the radio fields at the IRI site will never exceed safety standards. At the point of nearest public access, where the road from the site meets the local highway, these fields will be 10,000 times less than the maximum allowed by the standards. The low-frequency radiowaves generated by ionosphere heating by IRI will be some 400,000 times weaker than the background ELF fields found in a typical household.

The effects of IRI's operation on the environment will be slight and transient. Dr. Inan points out that lightning strikes about 100 times per second on this planet, and that each discharge has a far greater impact on the ionosphere and environment than the power of any one of these heating facilities.

Twenty years ago, scientists began to assess the environmental impact of solar-power generating satellites. Louis Duncan participated in this work. It was proposed to collect solar energy at the satellite, convert it to microwaves, and beam several gigawatts of power back to Earth though the atmosphere. Although possible atmospheric consequences were examined, no deleterious effects were found, Duncan says.

The Eastlund Patent

HAARP is not without critics. A small group of Alaskans has criticized HAARP as unsafe. While program officials have addressed such primary concerns as aircraft safety and radio interference, the HAARP critics are still not satisfied. For them HAARP is part of a "secret government agenda," and to bolster this suspicion they point to the Eastlund patent.

In the mid-1980s physicist Bernard Eastlund, who helped develop the plasma fusion torch, was employed as a consultant for Atlantic Richfield oil company. Eastlund was given the task of finding some use for trillions of cubic feet of natural gas from the oil fields in the North Slope of Alaska for which there seemed to be no commercial value.

Eastlund proposed to burn the gas and generate a vast amount of electricity—tens of gigawatts. The energy would be fed into an antenna array and beamed into space. Eastlund claimed that, with this broadcast of power, one could influence the atmosphere for such purposes as defending against missiles, jamming communications, and modifying the weather. Eastlund was awarded a patent for this scheme in 1987.[2]

Whether Eastlund's fantastic plans are feasible, or even desirable, is a matter of speculation. IRI is clearly not of such a grandiose scale. Its power will be several thousand times less than what Eastlund had proposed. But as a research tool, it will have no equal. Its plans and mission are well characterized, and as John Heckscher puts it: "HAARP is described in its environmental impact statement. It's not described by the Eastlund patent."

Notes

1. IRI's performance is also sometimes expressed in terms of "effective radiated power." It can direct its energy into a relatively small area of the atmosphere. By comparison, for a radio source whose energy is broadcast spherically in all directions to have the same effect, its power level would have to be a thousand times greater than IRI. So, while IRI's maximum power will be 3.6 megawatts, it can be said to have an effective radiated power of a couple of gigawatts. A single lightning stroke radiates an electromagnetic pulse of several gigawatts or more.
2. Patent No. 4,686,605.

University of Utah

The Sixth International Cold Fusion Conference took place Oct. 13 to 18 in Hokkaido, Japan, under the sponsorship of the New Energy and Industrial Technology Development Organization (NEDO), which is under contract with MITI, the Japanese Ministry of International Trade and Industry.

There were 176 registered participants from around the world: Australia (1), Canada (1), China (4), France (6), Germany (3), Hungary (1), India (1), Italy (15), Japan (91), Korea (2), Russia (8), Spain (3), Switzerland (2), Taiwan (1), U.K. (2), and the United States (37). Forty-three papers were read, and there were many poster papers.

Stormy History

Seven years ago, when Martin Fleischmann and Stanley Pons laid claim to being able to create a fusion reaction by electrochemical means, they were subjected to a furious attack by the scientific establishment. The onslaught was so bad that the Nobel Prize physicist Julian Schwinger resigned from the American Physical Society in protest over the APS' imposition of censorship against those scientists, including himself, who believed that such as thing as cold fusion might occur, and therefore the Fleischmann-Pons experiment should be treated seriously.

Scientists who believed they had positive results to report were denied access to any of the widely respected journals such as *Nature, Science,* or even *Scientific American,* while opponents of Fleischmann and Pons had no trouble gaining access to the media—whether specialist or popular.

To continue work in the field in the United States and Europe demanded an intrepid spirit in a climate in which scientists were many times threatened with loss of grant money and tenure. The situation was better in Japan, but even there, where the Ministry of International Trade and Industry (MITI) sponsored a broad-based effort to probe the phenomena, the scientific community at large was hesitant to accept cold fusion as a *bona fide* area for scientific inquiry.

In Italy, cold fusion research received modest institutional support over the years, but some of the tab was picked up by industry. In the United States, work at Stanford Research Institute was supported by the Electric Power Research Institute (EPRI) and, more recently, by the Japanese.

The ENECO consortium, supported by a number of investors, has sponsored some research in the United States and Russia, most notably by Dr. Edmund Storms formerly of Los Alamos National Laboratory. It has also purchased the University of Utah's share in the original Fleischmann-Pons patents. And Clean Energy Technology, Inc. (CETI) is trying to market a light water cold fusion device, which they say is at the point of commercial development.

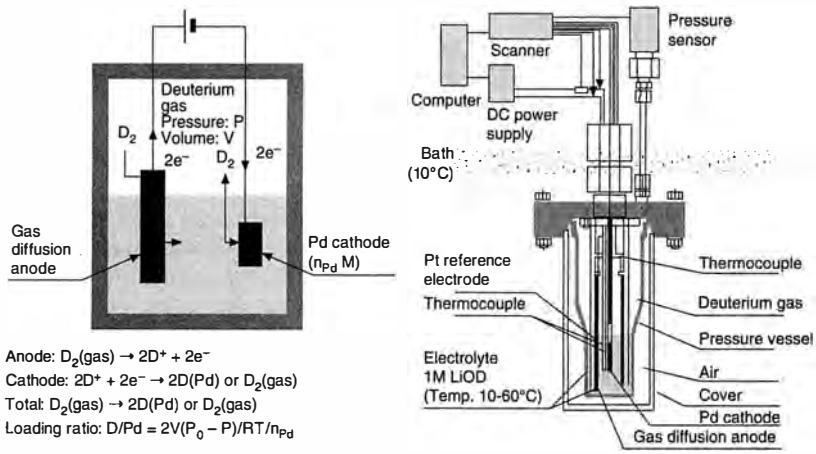
Certainly, the high hopes expressed by the two inventors, during the initial flurry of excitement, that a cold fusion generator was in the offing, have not yet materialized. Nonetheless, over the years, evidence has steadily accumulated that appears to substantiate the fundamental claim by Fleischmann and Pons, that it is possible to *catalyze,* as it were, a nuclear reaction by chemical means. The political climate however, remains negative and Fleischmann and Pons have yet to be granted a patent for a cold fusion cell.

Unfortunately, there has been little advance in going beyond the "is it real or isn't it" phase, to understanding what might actually be going on. Moreover, the *classic* Fleischmann-Pons experiment is still not easily repeatable, perhaps because of as yet unidentified differences in the palladium, or other hidden variables.

While there are many theories claiming to explain cold fusion, they will remain a somewhat empty exercise until the experiment is under better control. Nor is it absolutely precluded that the effects associated with cold fusion will turn out to be quite different in origin, not only from the initial conception of Fleischmann and Pons, but even from those of present workers in the field. For instance, the effects could be some hitherto unrecognized chemical phenomena.

The Sixth Conference

At the Hokkaido conference, Stanley Pons of IMRA Europe reported on his continued efforts to create a cell which can operate over an extended period of time in near-boil-off conditions. He has a new cell design in which there are four thermistors located in different parts of the cell, in order to improve the accuracy of excess heat measurement in an extremely turbulent environment. Three out of eight cells of this new design produced energies in the range of 294



IMRA JAPAN'S COLD FUSION CELL

IMRA Japan's cold fusion cell, based on fuel-cell technology, is a closed, pressurized, electrolytic system with a reversible hydrogen anode. There is no generation of O_2 gas because a gas diffusion anode is used. The loading ratio can be readily determined just by measuring D_2 gas pressure and temperature.

It is the only cell to show excess heat when tested by the laboratory of the New Energy and Industrial Technology Development Organization (NEDO) in Hokkaido. Excess heat of between 7 and 18 percent was observed in 11 cases. Reproducibility is still a problem, but more serious is the fact that with improved calorimetry, begun in April 1996, using a flow calorimeter, no excess heat has been observed in the 10 experiments so far performed.

megajoules. He estimates his precision of measurement to be within 5 percent. This would indicate a 250 percent rate of production of excess power.

A major criticism leveled against cold fusion research has been that it has failed to explain how a nuclear process could be taking place, considering that the typical products of fusion—tritium and helium-3—are not produced in sufficient abundance to account for the measured amounts of excess heat. That neutrons and tritium were observed, is of course of great scientific interest, even if another mechanism is involved for the excess heat production.

Thomas Claytor of Los Alamos National Laboratory could not attend the conference, but his paper was delivered by Edmund Storms, formerly of Los Alamos. Claytor and Storms, along with others, such as John Bockris, have demonstrated the production of tritium over the years since 1989. In this past year, Claytor concentrated on testing different palladium alloys. He uses a closed system in which deuterium is loaded into a palladium plate or wire by glow discharge methods, and tests the production of tritium by two methods—in real time, and by collection in water.

Using a cobalt-rhodium-palladium alloy, Claytor achieved a huge tritium burst peaking at around 1.5 nanocuries per liter. Similar results were reported by the Russian group led by Vitaliy Romodanov (Luch Laboratory, Moscow). The Russians, who use a method similar to Claytor's, believe that their finding has established a positive correlation between the amount of tritium produced and the atomic weight of the target.

Production of Helium-4

In a *hot* fusion reaction two deuterons (heavy hydrogen nuclei) will fuse to produce either the still heavier hydrogen isotope tritium (and an additional proton), or a new element, helium-3 (and an additional neutron). But the occurrence of a *cold* fusion event might perhaps be the result of the highly unlikely but still possible fusion of two deuterons to produce helium-4.

The fusion pathway involving production of helium-4 is not usual in known fusion reactions, and detection of helium-4 is relatively difficult in the laboratory because of possible contamination. Thus, the first reports of the finding of helium-4 were challenged. If the energy balance is maintained, one would also expect to see gamma ray emissions, but these are not typically associated with the reported production of helium-4 in cold fusion experiments.

At the Second Annual Cold Fusion Conference, Melvin Miles of the Naval Weapons Center at China Lake, California reported experiments in which he got an amount of helium-4 commensurate with the excess heat. At the next conference, Eiichi Yamaguchi also reported finding helium-4, but his work was also challenged.

At the Hokkaido conference, important new results were reported correlating the production of excess heat and helium-4.

Yoshiaka Arata and Yu-Chang Zhang at Osaka University have developed a two stage cold fusion experiment, in which electrolysis is used to produce extremely pure deuterium gas which is then diffused into a pressurized inner cell containing palladium microcrystals. According to the Arata "latticequake" model, a strongly coupled deuterium plasma is created within the palladium, where a fusion reaction takes place.

At the conclusion of their experiment, Arata and Zhang were able to detect the existence of significantly large amounts of helium, using mass spectrometry, after the palladium host solid was heated to a temperature of over 1,300 K. Arata and Zhang estimated the amount of helium-4 at a concentration of between 10^6 and 10^7 times that naturally found in air. They assume that the helium-4 is produced chemically, in a secondary reaction, by the combination of helium-3 and tritium. The excess energy in one example was several hundred megajoules per cubic centimeter, generated over periods of several thousand hours, using palladium black.

From Italy, two different laboratories reported significant helium-4. For several years, a group led by Daniele Gozzi (University of Rome) has been working to perfect a system that would correlate production of excess heat and helium-4. The problem they have faced is the elimination of helium contamination from the atmosphere.

This year they have achieved much improved reliability. In one experiment using four cells, that ran for 950 hours—

Marjorie Mazel Hecht

Cold fusion pioneers Martin Fleischmann (left) and Stanley Pons (second from right) describing their experiment at congressional hearings in 1989, as former Rep. Marilyn Lloyd (D.-Tenn.) looks on.

from which more than a thousand samplings were taken—they believe their data establish a satisfactory correlation between the production of excess heat and the release of the helium-4. They also saw some indications of X-ray emissions.

At the University of Turin, Tullio Bresani's group reported the detection of helium-4 from a gas-loading (rather than electrolysis) experiment. After first gas-loading a thin sheet of palladium, a constant electrical field of a few hundred millivolts per square centimeter was applied in order to increase the loading, which they estimate to reach .83. In one experiment, helium-4 emissions were observed, using a quadrupole mass spectrometer, and a check was made before and after the experiment to establish that no similar signal was detected with only deuterium in the cell.

Both Giuliano Preparata (University of Milan) and Francesco Celani (National Institute of Nuclear Physics, Frascati) have continued to report interesting results using a long, thin wire to which high voltages are applied longitudinally in an electrolysis experiment. The aim is to demonstrate the efficacy of inducing electromigration down the wire for increasing the cold-fusion effect.

An extremely interesting series of experiments has been run in Russia at the Russian Academy of Sciences in Moscow. These were reported by Aleksei Roussetski and Andrey Lipson.

In electrolyzing a thin palladium film coated with palladium oxide on both sides, Lipson found that there was a strong heat flash lasting from 2 to 7 seconds after electrolysis ended. This occurred as deuterium was deloading from the plate. Moreover, in the millisecond just before the heat emission, a neutron burst was noted.

The heat was measured at 60 to 100 joules per second, and the neutron burst was calculated at an intensity of 500 neutrons per square centimeter. Lipson believes that the mechanism involves storage of energy from cold fusion, which is first converted to elastic energy in the palladium while electrolysis is taking place, and then released in the form of excess heat.

In another experiment, his group tested the reaction of a number of different crystals with ferroelectric qualities, when subjected to a neutron flux. The crystals were loaded with deuterium and hydrogen in various proportions.

They found that in some instances the neutrons would be absorbed by the crystal, while in others, there would be an enhanced neutron flux as neutrons were released from the crystal. The same correlation existed with tritium, although the maximum amplification factor for tritium was about 10 times over background, as compared to double that for neutron flux. The result depends upon loading, temperature, and the ratio of neutron flux to neutron background.

Using thin sheets of palladium-oxide-coated palladium in electrolytic cells, Roussetski measured the emission of protons and neutrons as deuterium escaped the material. He found protons and neutrons emitted in equal amounts, which would appear to indicate an extremely low-energy "hot" fusion reaction, and with the emitted particles having anomalously low energies.

The New Alchemy

Fleischmann and Pons have supposed that the proclivity of palladium to sponge up hydrogen could be enhanced through electrolysis, so that a sufficient loading of deuterium into the palladium (around a ratio of one deuteron to one palladium atom) might allow the fusing of the stuffed-in deuterons to take place. Deuterium is a heavy isotope of hydrogen

Yoshiaka Arata (left) and Yu-Chang Zhang: Their two-stage experiment produces helium-4 and excess heat.

Celani applies high voltage to a long, thin wire to induce electromigration.

Carol White

Ikegami: Spinoffs from the cold fusion program are interesting.

Carol White

McKubre: "It is not a question of whether, but what the phenomenon is."

(containing one additional neutron in its nucleus).

One of the stranger features of the cold fusion story is the dichotomy that has developed between proponents of the *classic* cold fusion experiment by Fleischmann and Pons, and a grouping which believes now in a much broader range of possibilities. According to prevailing notions of how a fusion reaction might occur in the laboratory, it is not possible to fuse two ordinary hydrogen nuclei (protons); it is necessary that at least one of the nuclei contain one or two extra neutrons (to form a deuteron or triton).

The new alchemists, however, have presented experimental evidence to show that it is possible to get excess heat, and in some cases nuclear products—even the transmutation of light to heavier elements—by using ordinary purified tap water and substituting nickel for palladium as the target for the deposit of protons.

The possibility that we could capture the energy of the Sun (that is, produce a fusion reaction) in a table-top laboratory experiment, is already astonishing; these newer, alchemical claims, however, are even more extraordinary.

Of course, there is no conventional scientific explanation for how cold fusion takes place, under any circumstances. But the idea that electrolysis with a water-based electrolyte and nickel cathode could produce excess heat, is truly mind-boggling. Moreover, proponents of "light water" fusion claim that their experiments are much more reliable than the difficult-to-repeat *classical* Fleischmann-Pons experimental setup.

Following the discovery of light water cold nuclear reactions, researchers in the field began reporting that they could transmute lighter elements such as mercury, into heavier ones such as gold, using low energies to promote the transformation. Many of these researchers claim that they have rediscovered the secret knowledge of the alchemists of old.

Of course, such claims have been used by the opponents of cold fusion research to ridicule the work of Fleischmann and Pons. Such claims also give rise to a suspicion that, despite the absence of any obvious chemical recombination in a Fleischmann-Pons cell, or in the closed-cell configuration favored by the McKubre group at Stanford Research Institute, there must be some subtle chemistry involved, as opposed to a nuclear reaction.

Miley and the Patterson Group

There was a strong showing on the alchemical side, with George Miley (University of Illinois) reporting astonishing results with apparatus modelled on the Patterson cell, shown at the previous conference in Monte Carlo. This is a light-water electrolysis cell filled with a flat bed of nickel beads, variously coated.

Miley, in collaboration with the Patterson group, carried out more than a dozen experiments with similar thin-film microspheres. These experiments ran for periods ranging from 1 to 5 weeks.

Astonishingly, Miley claims that the metallic coatings of the microspheres underwent transmutation, and that the heavy-element reaction products, such as copper, aluminum and silver, exceeded the original weight of the metal by 50 percent in some cases. Some transmutations occurred with lighter weight elements as well.

In his summary remarks, Michael McKubre registered a certain skepticism about such claims. He said that he did not know how to assess transmutation, but if such claims proved true, then surely the existence of transmutation would dominate all future cold fusion conferences.

McKubre had tested the Patterson cell in his own laboratory, seeking to verify excess heat claims, but it seems clear from his conference presentation, that he has so far been unable to obtain any heat excess from the cells. He limited his presentation to heat transport equations relevant to fluid bed configurations.

The work of other experimenters, such as Tadahiko Mizuno and Tadayoshi Ohmori of Hokkaido University, who also claim to see transmutation products, was relegated to poster sessions.

Certainly these were the most dramatic results reported at the conference but, as Miley himself said, he has yet to rule out the possibility of contamination. Although his samples and his electrolyte were tested for purity, it is possible that

even minute amounts of trace elements can accumulate on a cathode surface.

Concluding Panel

All three speakers on the summary panel, Tullio Bressani (Turin University), Michael McKubre, and Hideo Ikegami (representing the Japanese program), agreed that the conference had been very successful.

Bressani discussed the helium-4 results. His conclusion was very positive: "From the beginning there was the problem of the reproducibility of the results and the establishment of its nuclear origin. Now at the time of this conference we have had positive confirmation on the second point. We have heard reports of more observations of excess heat and also independent confirmation from different groups of the presence of helium-4."

McKubre commented that more than 20 groups are seeing excess heat, using different experiments and differing techniques. For him there is no longer any question about what he described as the "robustness of heat observation"; he said it is not a question of "whether, but what the phenomenon is."

McKubre is still the first to admit that the conditions of reproducibility have yet to be sufficiently defined. There are obviously hidden variables yet to be identified and understood.

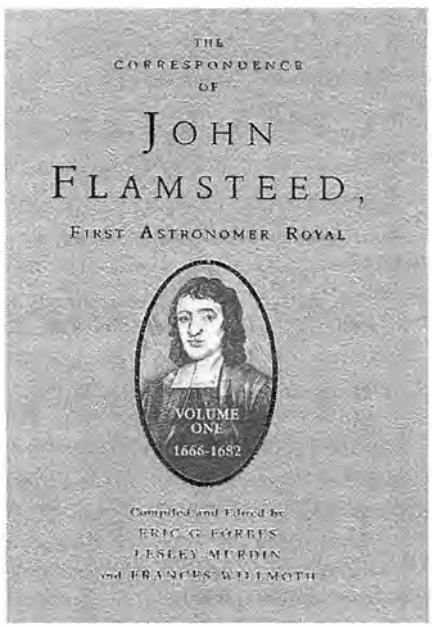
Ikegami took a rather different tack. He pointed to the spinoffs into entirely other areas that are already in sight from the cold fusion program. In this regard he cited the possibility of developing a phonon laser, based on a theory which Peter Hagelstein of MIT will be testing this coming year.

Highly loaded palladium hydrates hold promise, according to Ikegami, in developing new kinds of semiconductors, and may even be relevant to the development of new superconductors and the production of metallic hydrogen.

Ikegami expressed interest in new supervacancy states of the palladium lattice and the creation of a superlattice structure. He also mentioned the possibilities opened up by transmutation and the CETI cell. Lastly, Ikegami touched on theories of electromigration, new particles such as the erzion, and the "hydrex" model, which supposes a lower electronic ground state for the hydrogen atom to account for the phenomena witnessed in light and heavy hydrogen experiments.

Flamsteed's Correspondence

The Correspondence of John Flamsteed, The First Astronomer Royal, Vol. 1, 1666-1682
Edited by Eric G. Forbes, Lesley Murdin and Frances Willmoth
Philadelphia: Institute of Physics, 1995
Cloth, 955 pages, $280



The English astronomer John Flamsteed (1646-1719) played an important role in the scientific battles and discoveries of the 17th century, and this first volume of his correspondence is a valuable addition to the scholarship of the period.

Flamsteed's bitter fight with Isaac Newton and Edmund Halley included the well-known episode in which Flamsteed's research results were appropriated by his two unscrupulous enemies, and published in 1712—with numerous errors and distortions—in support of Newton's mathematical cosmology. When Flamsteed secured custody of the undistributed volumes a few years later, he burned all but the first section of each (or, as he expressed it, he "made a Sacrifice of them to Heavenly Truth").

It was Flamsteed, not Halley, who first proposed that what we now call Halley's comet was actually one comet, not two. (See Philip Valenti, "Why the Credit for 'Halley's' Comet Belongs to John Flamsteed," *Fusion,* Sept.-Oct. 1985, pp. 44-47.)

As the editors of the present volume point out, Flamsteed's reputation was "severely damaged" by his conflict with Halley and Newton, and their eventual dominance in English science. In 1806, it was still possible for a historian to write that Flamsteed was "universally esteemed as a good, a wise, and an amiable man"; but, by the first few decades of the 19th century, with Newton canonized as what one writer called "the archetypal example of scientific genius," interest in Flamsteed had lessened. Later historians "have continued to identify strongly with one side or the other in the conflict, and with Newton more often than not," the editors of this work note, in something of an understatement.

Unravelling the true history of the Flamsteed-Newton conflict will help to knock the latter off the throne from which he has ruled, for centuries now, over the conceptual degeneration of science.

The reader who wants to learn more about Flamsteed's battles with Newton and Halley will have to wait for the next volume of the correspondence, since this one goes only up to 1682, when Flamsteed was 36 years old.

These books are intended for the specialist, and the general reader will find them hard going. However, the editors have provided a helpful glossary of scientific terms and biographical sketches of people mentioned in the letters.

—Susan Welsh

BOOKS RECEIVED

Reconstructing Biology: Genetics and Ecology in the New World Order, by John Vandermeer. New York: John Wiley & Sons, 1996. Paper, 478 pages, $34.95.

Quest for Perfection: The Drive to Breed Better Human Beings, by Gina Maranto. New York: Scribner, 1996. Cloth, 335 pages, $25.00.

The Bell Curve Wars: Race, Intelligence, and the Future of America, edited by Steven Fraser. New York: Basic Books, 1995. Paper, 224 pages, $10.00.

Cancer Wars: How Politics Shapes What We Know and Don't Know About Cancer, by Robert N. Proctor. New York: Basic Books, 1995. Cloth, 368 pages, $25.00.

Understanding Radiation, by Bjorn Wahlstrom. Madison, Wis.: Cogito Books, 1995. Paper, 100 pages, $17.95.

Ozone—Sun—Cancer: Molecular and Cellular Mechanisms of Prevention, L. Bubertret, R. Santus, P. Morliere, eds. Paris: Les Editions INSERM, 1995. Paper, 223 pages.

Osler's Web: Inside the Labyrinth of the Chronic Fatigue Syndrome, by Hillary Johnson. New York: Crown Publishers, 1996. Cloth, 720 pages, $30.00.

Descartes' Error: Emotion, Reason, and the Human Brain, by Antonio R. Damasio. New York: Avon Books, 1995. Paper, 312 pages, $12.50.

The Great Dinosaur Extinction Controversy, by Charles Officer and Jake Page. Reading, Mass.: Addison-Wesley, 1996. Cloth, 209 pages, $25.00.

America the Powerless: Facing Our Nuclear Energy Dilemma, by Alan E. Waltar. Madison, Wis.: Cogito Books, 1995. Paper, 235 pages, $22.95.

The Snows of Olympus: A Garden on Mars, by Arthur C. Clarke. New York: W.W. Norton, 1995. Cloth, 120 pages, $25.00.

Bluebells and Nuclear Energy, by Albert B. Reynolds. Madison, Wis.: Cogito Books, 1996. Paper, 302 pages, $22.95.

Chemicals, Metals and Men—Gas, Chemicals and Coke: A Bird's-Eye View of the Materials That Make the World Go Around, by Nils Anderson, Jr. and Mark W. DeLawyer. New York: Vantage Press, 1995. Hardcover, 280 pages, $19.95.

Superconductivity, by Charles P. Poole, Jr., Horacio A. Farach, and Richard J. Creswick. San Diego: Academic Press, 1995. Cloth, 620 pages, $149.00.

Photonic Crystals: Molding the Flow of Light, by John D. Joannopoulos, Robert D. Meade, and Joshua N. Winn. Princeton: Princeton University Press, 1995. Hardcover, 137 pages.

Nano: The Emerging Science of Nanotechnology—Remaking the World Molecule by Molecule, by Ed Regis. Boston: Little, Brown, 1995. Cloth, 336 pages, $23.95.

The Space Environment: Implications for Spacecraft Design, by Alan C. Tribble. Princeton: Princeton University Press, 1995. Cloth, 204 pages, $49.50.

Rain of Iron and Ice: The Very Real Threat of Comet and Asteroid Bombardment, by John S. Lewis. Reading, MA: Addison-Wesley, 1996. Hardcover, 236 pages, $25.00.

Extraterrestrials: Where Are They? by Ben Zuckerman and Michael H. Hart. Second edition. New York: Cambridge University Press, 1995. Hardcover, 239 pages.

Beginner's Guide to the Sun, by Peter O. Taylor and Nancy L. Hendrickson. Waukesha, Wis.: Kalmbach, 1995. Paper, 160 pages, $19.95.

A Survey of Physical Theory, by Max Planck. New York: Dover Publications, 1993. Originally: A Survey of Physics, 1925. Paper, 117 pages, $6.95.

Bose-Einstein Condensation, edited by A. Griffin, D.W. Snoke, and S. Stringari. New York: Cambridge University Press, 1995. Hardcover, 602 pages.

The Anatomical Exercises: De Motu Cordis and De Circulatione Sanguinis in English Translation, by William Harvey. New York: Dover Publications, 1995. Reprint of 1953 edition. Paper, 202 pages, $8.95.

The Invisible World: Early Modern Philosophy and the Invention of the Microscope, by Catherine Wilson. Princeton: Princeton University Press, 1995. Cloth, 280 pages.

The Key to Newton's Dynamics: The Kepler Problem and the *Principia,* by J. Bruce Brackenridge. Berkeley: University of California Press, 1996. Paper, 299 pages, $19.95.

The Private Science of Louis Pasteur, by Gerald L. Geison. Princeton: Princeton University Press, 1995. Cloth, 378 pages, $29.95.

Science and Culture: Popular and Philosophical Essays by Hermann von Helmholtz, edited by David Cahan. Chicago: University of Chicago, 1995. Paper, 440 pages, $17.95.

Catch Up with 21st CENTURY SCIENCE & TECHNOLOGY

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1989

September-October

"How Space Technology Makes Us Healthier" *Marsha Freeman*

"Environmental Pollution and the Causes of Human Cancer" *Bruce N. Ames*

Despite all the scare stories about carcinogens, Americans are healthier than they ever have been. An expert on cancer causation sets the record straight on six of the most frequent errors about pollution and cancer.

"Gaia: Ecologists Embrace the Earth Goddess" *Rogelio A. Maduro*

1990

Summer

"Mining Helium on the Moon to Power the Earth" *Marsha Freeman*

As the world approaches the 21st century, vast increases in total energy production and consumption per capita are required. Helium-3, sitting on the surface of the Moon, can fuel the greatest period of economic development in mankind's history.

"'Mind Bombs': Putting Greenpeace in Perspective" *Ellen Chance*

"We fire images rather than missiles—mind bombs delivered by the world media." Think about this self-description of Greenpeace the next time you get a "save the dolphins" mailing from this $87-million-a-year environmentalist multinational, whose propaganda campaigns stab at the heart of Western civilization.

"Don't Bury Nuclear Waste: Recycle and Reprocess It!" *An interview with nuclear scientist Michael Fox*

1991

Spring

"Fission and the Breakthrough of Women in Fundamental Scientific Research" *Jonathan Tennenbaum*

Radical feminists and others who fear nuclear energy, and technology in general, should take a lesson from the women who founded nuclear science.

"How Nuclear Fission Was Really Discovered" *Jonathan Tennenbaum*

For years, students had been taught that the fission of uranium was physically impossible. Nuclear chemist Ida Noddack objected, but her voice was ignored for 5 years—until Hahn and Strassmann's "discovery" of 1938-1939.

"LaRouche's 'Oasis Plan': The Only Real Basis for Mideast Peace"

Economist Lyndon LaRouche's Grand Design for regional infrastructure development, first proposed 15 years ago, is still the only way to build a stable peace in the Mideast.

"Hyperbolic Functions, the Catenary, and the Human Mind" *Carol White*

"A New Look at Negative Curvature: Applying Beltrami's Geometry to Astrophysics" *Charles B. Stevens*

1993

Spring

"Ole Romer and the Discovery of the Speed of Light" *Poul Rasmussen*

"Are Soap Bubbles Smarter Than You Are?" *Raynald Rouleau*

"Nuclear Report: 50 Years of Fission" *Marjorie Mazel Hecht*

"Hanford Workers' Health and the Decline of Scientific Debate" *Michael Fox*

"Food Irradiation and Biotechnology Necessary to 'Protect People'" *An Interview with Julia Child*

"The Third International Cold Fusion Conference: Solid State Fusion Comes of Age" *Carol White*

Fall

"Hermann Oberth: The Father of Space Travel" *Marsha Freeman*

"Reviving de Broglie's Wave-Particle Synthesis" *Philippe Guéret*

"What's Wrong with Hawking's Theory of Time and Space?" *B.A. Soldano, Ph.D.*

"Virginia Political Vendetta to Jail *21st Century* Editor" *Interview with Laurence and Marjorie Hecht*

1994

Summer

"Recapturing the Promise of Apollo" *Marsha Freeman*

"Plutonium As a Resource Now and in the Future" *Dr. Dixy Lee Ray*

"An Economist's View of Gauss's 'Pentagramma Mirificum'" *Lyndon H. LaRouche, Jr.*

The last 600 years of scientific and cultural development would not have been possible had the great thinkers of the 15th century used the methods that dominate economics today.

1995

Spring

"It's Time to Bury Darwin and Get On With Real Science" *Carol Huginin*

"The Breeder Reactor—Affordable Energy Forever" *Bernard L. Cohen*

"Great Projects Are the Path to Global Economic Recovery" *Lyndon H. LaRouche, Jr.*

Summer

"A Tragedy of Science: The Life of Max Planck" *Caroline Hartmann*

"Hubble's Quasar Images: A Moment of Truth" *David Cherry*

"From Hot to Cold Fusion: A Look at the Life of Yoshiaka Arata" *Carol White*

"Special Report: A Warning on the 'Wise Use' Movement"

Fall

"Eureka! Rediscovering the Method of Archimedes" *Bob Robinson*

"Kenneth Arrow Runs Out of Ideas, But Not Words" *Lyndon H. LaRouche, Jr.*

An exposé of *Science* magazine's promotion of environmentalist mumbo-jumbo as peer-reviewed objective science.

"The 5th International Cold Fusion Conference: Slow, Steady Progress and Some Fast Talk" *Carol White*

"Court Affirms Greenpeace Ties to Earth First! Terrorists"

Winter

"Johannes Kepler's *Mysterium Cosmographicum:* A Guide to the Harmony of the Mind and the Universe" *Ralf Schauerhammer*

"Riemann Refutes Euler" *Lyndon H. LaRouche, Jr.*

"Philosophical Fragments" *Bernhard Riemann* (First English Translation)

The Darwin Debate:

"In Defense of Darwin" *Karol Sabath*

"Bury Darwin—It's Overdue" *Carol Hugunin*

"A Master Polyhedra Builder Demonstrates His Art" *Charles Stevens*

In This Issue:

U.S. Geological Survey/NASA

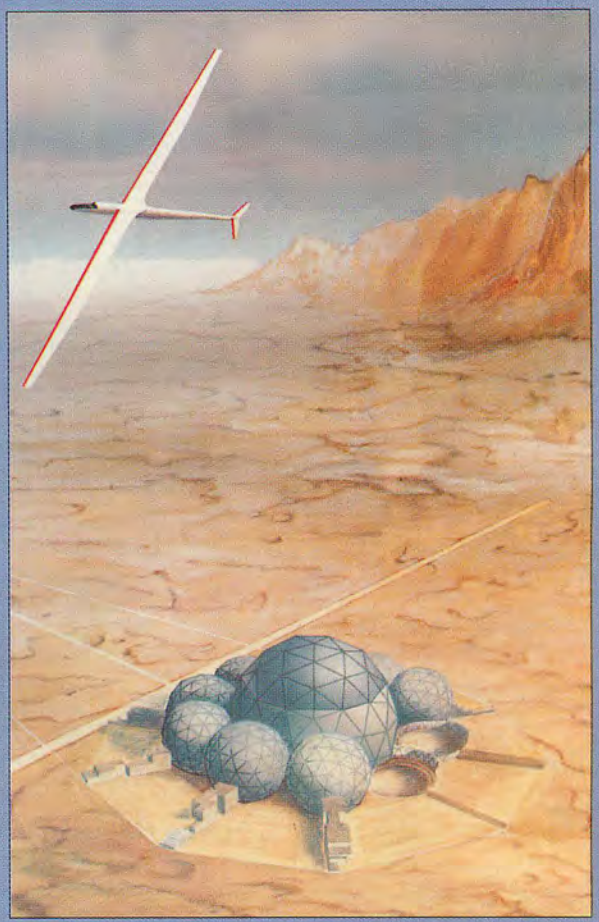

Illustration by Christopher Sloan

Life on Mars then—and in the future. Above: The massive Vallis Marinaris canyon, which straddles the equator of Mars, could have been formed only by the flow of immense amounts of water. Right: An artist's depiction of the first Mars city, Kepleropolis.

PUTTING LIFE ON MARS

Industrializing the Moon and building a science city on Mars is neither pie in the sky, nor something simple that can be done with tin cans. In the cover story, economist Lyndon H. LaRouche, Jr., explains how a 40-year mission to Mars would save the economy—and help save our souls. The key to understanding economic science is what LaRouche calls "the Columbus Principle": the exercise of those creative powers of the individual human mind, by means of which valid, original discoveries of universal principle are discovered. By forcing the pace of such discoveries through such a 40-year mission, we change the relationship of man to the universe; it is not just the material conditions of life that are improved.

In **"The Woman on Mars,"** a 1987 draft movie script, LaRouche brings the "Columbus Principle" to life. No one who reads it can miss the point of how a 40-year mission to discover new worlds would transform the sorry mess here on Earth. Rounding out the Mars package is a review by Marsha Freeman of the upcoming scientific missions that will explore the planet.

Three Gorges Project Development Corporation

THE EURASIAN LAND BRIDGE TO THE 21ST CENTURY

That China has plans for a "new era of the continental bridge," to develop and industrialize Eurasia using the most advanced technologies, is almost unknown in the West. In the Special Report, Jonathan Tennenbaum reviews this exciting plan and describes the concept of the high-tech infrastructure development corridor. Can the United States afford to ignore this potential economic boom?

An artist's depiction of the Three Gorges Dam on the Yangtze, China's largest river. The $6 billion project will be the largest hydroelectric project in the world, producing 84.7 billion kilowatt-hours of electricity yearly.