21st CENTURY SCIENCE & TECHNOLOGY

FALL 1997

$3.50/IN CANADA $4.50

LET'S STOP RADIATION HYSTERIA
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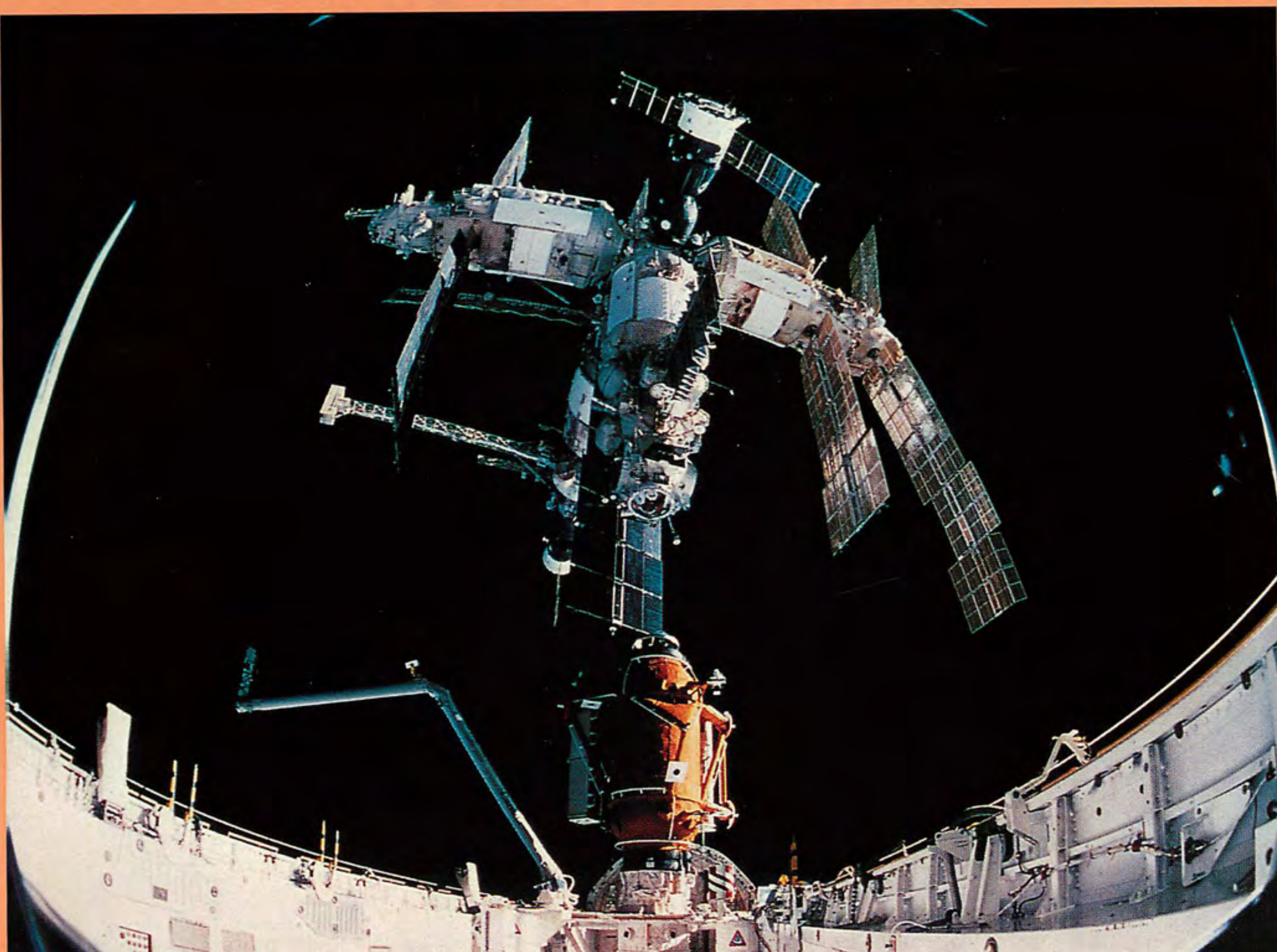
40 Years After Sputnik

The U.S. and Russia in Space



Evolution or Revolution: The Real Darwin

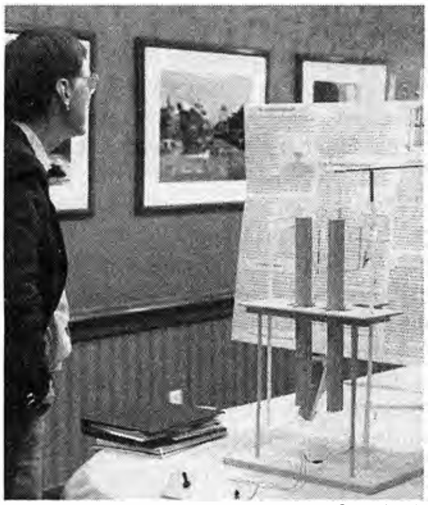
LaRouche on Spaceless-Timeless Boundaries

China's Nuclear Leap

21st CENTURY SCIENCE & TECHNOLOGY

Vol. 10, No. 3 Fall 1997

Features



Stuart Lewis

Students today must relive the process of discovery of new physical principles made by past discoverers, and learn the method for making valid new discoveries of principle, as LaRouche discusses (p. 46). Here, a model of Ampère's Second Equilibrium Experiment, constructed by Bob Bowen for the Schiller Institute.

News

Departments

On the cover: A view of the Mir, taken from the Space Shuttle Atlantis, just before docking, in July 1995. Photo courtesy of IMAX Corp./Lockheed Martin; Sputnik image courtesy of RSC Energia, Korolev, Russia. Cover design by Rosemary Moak.

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year in 1997, every third month, by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 20175. Tel. (703) 777-7473.

Address all correspondence to **21st Century**, P.O. Box 16285, Washington, D.C. 20041.

Second-class postage is paid at Leesburg, Va. and additional mailing offices.

Dedicated to providing accurate and comprehensive information on advanced technologies and science policy, **21st Century** is committed to restoring American scientific and technological leadership. **21st Century** covers the frontiers of science, focusing on the self-developing qualities of the physical universe in such areas as plasma physics—the basis for fusion power—as well as biology and microphysics, and including groundbreaking studies of the historical development of science and technology. Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

Subscriptions by mail are $25 for 6 issues or $48 for 12 issues in the USA and Canada. Airmail subscriptions to other countries are $50 for 6 issues. Back issues are $5 each ($6 foreign). Payments must be in U.S. currency.

POSTMASTER: Send address changes to 21st Century, P.O. Box 16285, Washington, D.C. 20041-0285.

Printed in the USA ISSN 0895-6820

PUT MAN IN SPACE!

The Extraterrestrial Imperative

The fact that millions of people around the world have been watching the Mars Pathfinder mission, which began on July 4, with great interest and excitement, should not be a big surprise to close observers of the human spirit.

Throughout the last 20 years, while the media and Hollywood have worked tirelessly to replace enthusiasm for space exploration with stories about aliens, being stranded in space, or the prevalence of UFOs, 10 million people a year have been visiting the National Air and Space Museum in Washington, learning about man's conquest of the skies and of space.

The Pathfinder lander sitting on Mars, with its diminutive companion, Sojourner, roving about the landing site, reminds Americans, that as difficult as a task might seem, it can be accomplished. There are whole new worlds to explore, about which we know relatively little. There is enough exploring to do in space to keep the next hundred generations of humans busy.

We also have well-thought-out plans for how to accomplish such exploration and colonization. Economist Lyndon LaRouche, for example, has described in detail a Great Project to establish a science-city on Mars in the next 40 years (see *21st Century,* Winter 1996-1997, p. 16). As he notes, this 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, and which is the true inspiration of entire peoples.

In the same spirit, space scientist Krafft Ehricke, 25 years ago, coined the term "extraterrestrial imperative," to convey the idea that such exploration is not an arbitrary activity for mankind, but a necessary one. "If God had wanted man to explore space, He would have given him a Moon," Ehricke often stated in his writings and public presentations.

Ehricke's life's work, which is not as widely known as it should be (he died in 1984), is a technological and philosophical treasure that needs to be brought back to life, especially now. (A memoir on Ehricke appears in *21st Century* Winter 1994-1995, p. 32.)

Ehricke: No Limits to Creativity

Before a rapt audience in New York City in November 1981, Ehricke described how the Earth's biosphere has faced two great crises during its evolution. These were overcome, he said, through the development of photosynthesis, the ability of a plant to produce its own "resources," and the subsequent development of multi-celled life that could make use of the new oxygen atmosphere that had been created by the plants. In each crisis, he said, "life had only three choices: Give up and perish, regress to a minimal state of existence, or advance and grow."

It was very clear to Ehricke that the human race is now faced with those same three choices. He showed, in graphic form, that the alternative of a no-growth policy would lead to the kinds of catastrophic convulsions we are experiencing today: "geopolitical power politics, wars over natural resources, waves of epidemics, death-oriented population stabilization, extreme poverty," and *real* ecological crises. In 1982, he wrote: "In 1979, of all things in the Year of the Child of the United

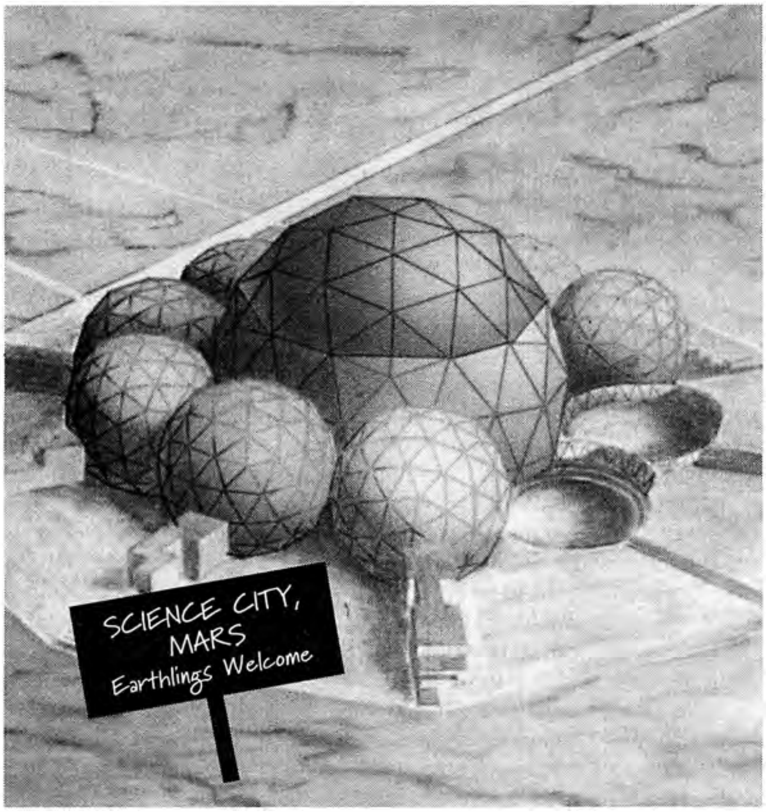
Nations, there were 12 million children who did not reach their first birthday. That's 50 percent more than all battle deaths in World War I, in four years. And that is an outrage to a species that calls itself civilized."

By the 1960s, the concept of "growth" was being challenged by a melange of so-called environmentalists and Malthusian zero growthers. Ehricke developed the concept of the extraterrestrial imperative to confront head-on this attack on the unique nature of man.

The central concept Ehricke developed is "the distinction between multiplication and growth." In contrast to the *Limits to Growth* comparison of man's growth to the "mindless and senseless multiplication of lillies in a pond" (or today, Prince Philip's comparison of the growth of population to cancer), Ehricke stated in a 1982 article, "Growth, in contrast to multiplication, is the increase in knowledge, in wisdom, in the capacity to grow in new ways." As far as "limits" go, Ehricke pointed out that the Malthusians, who never consider space exploration as a domain of man's activity, see the Earth as a closed system. "I don't," he said. "Humanity's action world is no more closed than it is flat." Man is not the polluter of the Earth, but the "naysayers" are "the polluters of our future."

In a 1973 article about his mentor, Hermann Oberth, Ehricke wrote, "For me, the development of the idea of space travel was always the most logical and most noble consequence of the Renaissance ideal, which again placed man in an organic and active relationship with this surrounding universe and which perceived in the synthesis of knowledge and capabilities its highest ideas. . . . The concepts of 'limit' and 'impossibility' were each relegated to two clearly distinct regions, namely the 'limit' of our present state of knowledge and the 'impossibility' of a process running counter to the well-understood laws of nature."

Looking at the future from the standpoint of the past, Ehricke observed that "it is an extraordinary fact that we find ourselves at one of the very rare nodal points in an evolutionary history, in which the confluence of patient, negentropic processes of eons accumulates a tremendous growth thrust potential whose acceptance and discharge will creatively play itself out over another eonic period." This thrust will be toward an Earth-based system, that is no longer closed.



Countering the anti-science description of the view of the Earth as seen by the Apollo astronauts on their way to the Moon, as a "fragile" globe that mankind is destroying, Ehricke wrote, "Earth is not merely a spaceship. It is a member of the Sun's convoy traversing the vast ocean of our Milky Way galaxy. . . . It is fortuitous that we need only to traverse open space to reach our remote terrestrial resources. . . . Our companion worlds are underdeveloped. Earth is the only luxury passenger liner in a convoy of freighters loaded with resources. These resources are for us to use, after Earth has hatched us to the point where we have the intelligence and the means to gain partial independence from our planet."

On to the Moon, and Mars

Krafft Ehricke spent 20 years proving in exquisite detail, that man indeed does have the "intelligence and the means" to begin the creation of a new civilization on Earth's nearest neighbor, the Moon. From there, the next target is the most Earth-like planet in the Sun's convoy, traversing the ocean of space: Mars.

After we have gathered first-hand knowledge about how to live in space on the International Space Station, we will be well-positioned to return to the Moon and set up shop there, for scientific observation, and to learn how to "live off the land," using the resources on the Moon with revolutionary new technology developed on Earth, to establish cities and a new civilization.

It is only natural that the expectation of most of those who have followed the extraordinary Pathfinder mission, is that after a series of necessary precursor missions there will be a program in place to send people to Mars. At the present time, there is no such plan in place. There are some promoting a "get-rich-quick" manned Mars mission, to go as soon as possible, regardless of the danger to the crew or the limited science and technological development that would result.

Four months after he took office, President John F. Kennedy announced the Apollo program, in May 1961, which had a different, long-term vision for this nation's space program. He said, "Now it is time to take longer strides, time for a great new American enterprise, time for this nation to take a clearly leading role in space achievement, which in many ways holds the key to our future on Earth."

Now is also such a time.

Letters

Why Not 'Mars Direct'?

To the Editor:

While I normally enjoy Marsha Freeman's writings, I was very disturbed by her review of Robert Zubrin's book, *The Case for Mars,* in the Spring 1997 issue. For the record, I am not associated with, or even have spoken to, Robert Zubrin.

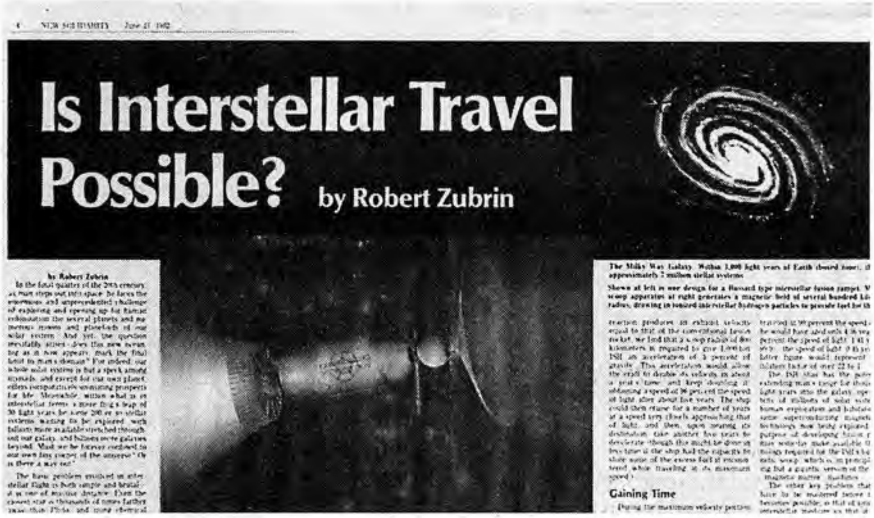
Freeman misstates that the concept will, "require a stay on the Mars surface of 550 days." This is the whole point: to design a mission that spends most of the time on Mars, not in transit. Further, it is not a function of the type of vehicle or propulsion system that dictates the 550 days; it's the positions in orbit of Mars and Earth on a conjunction type flight. . . .

What comes through is that this review is a blind, knee-jerk response to the fact that Zubrin is proposing a way to initially get to Mars that she doesn't like: Without a nuclear engine, and without massive Moon base and space stations. Because of this, she does not read his book with an objective eye. He clearly states that a nuclear engine would be better for exploration of Mars. The problem is, we don't have one. We're not likely to get one, either, if the reason for its development is to go to Mars. That requires overcoming two ignorant opposition groups (anti-space and anti-nuclear). It ain't gonna happen in the foreseeable future.

Freeman dislikes his 10-year concept. However, Zubrin is simply facing political reality. . . .

Art Hanley
Sacramento, Calif.

Marsha Freeman Replies


Is Interstellar Travel Possible? by Robert Zubrin

Gaining Time

Robert Zubrin wrote about fusion rockets and interstellar ramjets in this June 21, 1982, article in New Solidarity *newspaper.*

It is very easy, if you are interested in and excited by space exploration, to become enticed by Bob Zubrin's "get-rich-quick" manned Mars mission, which he calls "Mars Direct." Especially since the landing of the Mars Pathfinder spacecraft on July 4, the question is once again being asked, when are we going to send people to Mars?

Before Zubrin became demoralized by the lack of vision exhibited by most of the past decade's national leaders, he was an enthusiastic promoter of pushing the outside of the envelope of science and engineering, to develop the technologies for future space exploration. Then, he was not proposing to use 20-year-old expendable chemical rockets, but interstellar fusion ramjets and exploration of other galaxies.

In his 1982 article on this subject, published in *New Solidarity,* Zubrin proposed that while it might take 50 years to start the colonization of the galaxy using an interstellar ramjet, nearer-term fusion powered rockets "are more than adequate for complete mastery of the Solar System."

Indeed, it is the development of dramatically new propulsion technologies that will make colonization of our Solar System safe and scientifically productive. Mr. Hanley is misinformed. The alignment of the planets is only a critical factor, when the propulsion system being used is limited to chemical or first-generation nuclear propulsion technology.

Were we to develop the constant-thrust thermonuclear fusion rockets Bob Zubrin was writing about in the 1980s—as was, also, space pioneer Krafft Ehricke and Lyndon LaRouche—we would be free to come and go between the Earth and Mars, much more often than at 26-month intervals, and would not have to stay on the surface for 550 days, which is all that is possible with Zubrin's chemical rockets.

More than a convenience, this possibility to quickly end a mission, if necessary, and return to Earth within a reasonably short period of time, is the level of safety any astronaut making the trip would, and should, expect. Zubrin's Mars Direct aims to replace technological innovation and greater safety with expediency.

Do not kid yourself. There will be no manned missions to Mars if there is not the commitment to take on a fight with the anti-space, anti-nuclear movement in this country. People who represent that point of view also believe that science and technology are dangerous, that the government should not be wasting money on such endeavors, and that a return to a more "primitive" time, with many fewer people, would solve the world's "problems" (like alleged global warming, limited resources, or other hoked-up scare scenarios).

Facing political reality does not mean giving up your principles to garner support from the likes of budget balancers like Newt Gingrich (who is pictured with Zubrin in his book). It means understanding that the fight for a manned Mars program, and the return to the Moon, will require a political mobilization to change the cultural pessimism in the country—the kind of pessimism that results in articles saying that NASA never landed the Pathfinder spacecraft

Continued on page 7

The Lightning Rod

My Dear Friends:

Encouraged by your kind response to my return as a columnist in this fine publication, I am continuing my comments on some old and nasty views that seem, unfortunately, to have taken on a new life today. As you undoubtedly know, I am an ardent practitioner of hearty eating and a well-balanced diet. So, it is with alarm that I have viewed the increasing polemics against protein, especially those against meat. Of course, tastes vary: Some prefer fowl or venison, and others beef; some just plain do not like meat. Such diversity is to be expected.

But the vehemence with which the anti-meat, anti-protein diatribe is waged today; the full-page ads directed at turning people, especially children, away from eating the meat of "animals with faces"; the ever-shifting, so-called scientific results on what is, or what isn't, good for one—all this brings me to the inescapable conclusion that the attack on a protein source that is essential for human growth and development has other motives.

I am reminded of what the English social commentator Charles Dickens, had to say about diet in his 1837 novel, *Oliver Twist.* Poor Oliver, a young orphan apprenticed to an undertaker, and fed the table scraps considered unfit for the family dog, one day rebelled against his unjust treatment. Alarmed, the lady of the house, a Mrs. Sowerberry, called on the workhouse beadle, Mr. Bumble, for help. (Mr. Bumble had arranged for Oliver to leave the workhouse for the Sowerberry apprenticeship.)

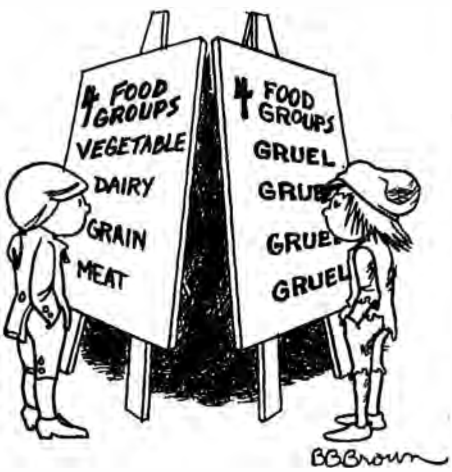
The rebellious Oliver, however, locked in the cellar, screamed uncooperatively at Mr. Bumble.

Dickens describes the scene thus: "'Oh, you know, Mr. Bumble, he must be mad,' said Mrs. Sowerberry. 'No boy in half his senses could venture to speak so to you.'

"'It's not Madness, ma'am,' replied Mr. Bumble, after a few moments of deep meditation. 'It's meat.'

"'What?' exclaimed Mrs Sowerberry.

"'Meat, ma'am, meat,' replied Bumble with stern emphasis. 'You've overfed him, ma'am. You've raised an artificial soul and spirit in him, ma'am, unbecoming a person of his condition: as the board [of the workhouse], Mrs. Sowerberry, who are practical philosophers, will tell you. What have paupers to do with soul or spirit? It's quite enough that we let 'em have live bodies. If you had kept the boy on gruel, ma'am. This



would never have happened.'

"'Dear, dear!' ejaculated Mrs. Sowerberry, piously raising her eyes to the kitchen ceiling: 'this comes of being liberal!'. . .

"'Ah!' said Mr. Bumble. . . . 'The only thing that can be done now, that I know of, is to leave him in the cellar for a day or so, till he's a little starved down; and then to take him out, and keep him on gruel all through his apprenticeship.'"

Let Them Eat Gruel

This gruel philosophy, as described by Dickens, predominated in England, when, in 1834, the government ended welfare—or what was called "outdoor relief," which had supplemented the poor wages of laborers with families. Those paupers who were unfortunate enough to land in a workhouse, were put on a diet of $1\frac{1}{2}$ pints of gruel per day and a total per week of 12 ounces of bread, 14 ounces of suet or rice pudding, and 2 ounces of cheese. Barely enough to sustain "live bodies," to use Bumble's terminology.

Now, dear readers, to come back to current times, consider how this gruel philosophy fits so nicely with that odious sentiment, put forward in *The Times* of London as recently as Jan. 5, 1995, by Sir William Rees-Mogg (a modern version of Mr. Chief-Bumble): Namely, that the post-industrial society requires only 5 percent to be the educated elite "on whose success we shall all depend," while the other 95 percent can labor without benefit of education—and, presumably, without benefit of the "meat" diet for those deemed worthy enough to have "soul and spirit."

Well, dear friends, as you know, such philosophy, in my day, was why we rebelled against the British crown to establish this republic.

Gingrich Science Speaks Out

by Lyndon H. LaRouche, Jr.

A guest editorial, entitled, "Scientifically Illiterate vs. Politically Clueless," from *Science* magazine May 23,[1] might have had the more appropriately descriptive title, "How to Sell Science to an Illiterate Newt Gingrich, Now That the Soviet Union Is Gone."

The author of that editorial, Gregory van der Vink,[2] paints himself as one of those unfortunates whom Jena University's Friedrich Schiller identified as the *Brotgelehrte,* a term which I have freely translated into English as "those who sing for their supper, not for the music."

Crucial statements included in the piece, are evidence demonstrating that he is an ideologue of that specific, now "politically correct" type of science-apostate, familiar to us from close study of that mid-1960s cultural paradigm-shift, the which produced the "rock-drug-sex" youth-counterculture of that period. The editorial is built around an array of code-words and styles of expression, alien to science, but specific to ideological strains typified by the Columbia University campus's 1968-1969 ration of self-styled, Ford Foundation-sponsored "SDS Crazies."

The following two excerpts typify the ideologically "deconstructionist" content and flavor of the editorial as a whole:

"But science is not about providing answers to society's problems."

As it might be argued, by the same logic, that medicine "is not about" solutions for disease. He continues:

"Rather science provides a way to address systematically problems on the basis of an understanding of the natural world. Each conclusion is merely the best hypothesis to fit the available data."

Van der Vink supplies a second, distinct, although related point, a few sentences later:

"As scientists we are called upon to find the best solution that fits within the political, social, and economic boundary conditions. As the boundary conditions inevitably change, scientists appear to disagree, the media reports on the controversy, and the public watches in frustration. Uncomfortable with moral implications and value judgments, we remain outside the mainstream of the decision-making and allow policy-makers to set the course while we criticize from afar. . . ."

In summary, a "politically correct science," which "sings for its supper, not the music." In the jargon of Columbia University's self-styled "SDS Crazies," "relevant."

The editorial setting within which van der Vink situates those two, dubious observations, is the pervasive premise of that piece as a whole. He premises the entire piece on the fraudulent assertion, that, now, since military imperatives are things of the past, science must discover new uses for itself. Those new uses, he proposes, might be uncovered by "scientists . . . with a broad understanding of science and a basic literacy in economics, international affairs, and policy-making."

In making our general reply to that editorial as a whole, we focus on his included, conclusory assumption that any scientist with "a broad understanding of economics" might be in accord with that editorial's definitions of either science or economics.

Economic science, otherwise known as "physical economy," was founded by papers of Gottfried Leibniz from the interval 1671-1716. Through various channels, Leibniz's economic science became hegemonic among the 18th century circles closely associated with the leadership of Benjamin Franklin. The philosophy of statecraft and of economic science supplied by Leibniz, was combined with the lessons of the 17th century's Massachusetts Bay Colony in successful use of a paper currency; this combination provided the underlying assumptions of U.S. Treasury Secretary Alexander Hamilton, Mathew Carey, Friedrich List, Henry C. Carey, et al., in defining what was known worldwide as the "American System of political-economy." This system of science-driven technological progress, was reactivated under President Abraham Lincoln, to the effect of the post-Civil War U.S.A. as, then, and for over a decade, both the world's leading military power, and leading agro-industrial economy.

All of the great successes of the modern sovereign nation-state, since Louis XI doubled the national income of France, over the 1461-1483 term of his reign, have flowed from the kind of science-driver economy typified, early on, by the Renaissance figure of Leonardo da Vinci. Later, this is typified by the work of France's Minister Jean-Baptiste Colbert, the Monge-Carnot circles around the 1791-1814 *Ecole Polytechnique,* and the roles of Henry Carey and Franklin's great-grandson, Alexander Dallas Bache, in providing the basis, in the traditions of the Monge-led *Ecole Polytechnique,* and in collaboration with German science, for the science-driver crash-economy program of Lincoln's administration. The latter American example, after 1876, became the model used for the late-19th-century industrial revolution in Germany.

The kernel of per capita physical-economic growth in any modern economy, has been a tripartite interdependency among the fostering of universal, compulsory Classical education in art and science, the development of the pure-science-driven strategic machine-tool-design sector of the economy, and the ability of a properly educated labor-force to assimilate scientific discovery for efficient progress of rapid rates of advances in technology of both design of products and productive processes. There are virtually no problems in

SCIENCE

EDITORIAL

Scientifically Illiterate vs. Politically Clueless

Following the Soviet launch of Sputnik, Congress responded to the perceived technology [illegible] "[illegible] of our defense, as essential as ... [illegible]."

Today, however, cries of technology gaps are viewed skeptically by a nation more concerned with battling the federal deficit than with fighting communism. After four decades of unquestioned federal support for science under the broad justification of super- [illegible] against short-term goals. As observed by a previous director of the National Science Foundation, "the days of throwing money over the wall are over." So far, the response of the [illegible] investment in basic research would be obvious beyond the requirement of explanation.

To help defend ourselves against future funding shortfalls, we have indignantly come forward with a litany of examples for how science has improved our society. While hailing our successes, we artfully dodge questions about why we have not found solutions to such seemingly simple yet intractable problems as waste disposal, natural hazards, and disease control. In doing so, we gloss over the scientific process and create the impression that our results are answers that are good for all time.

But science is not about providing answers to society's problems. Rather science provides a way to address systematically problems on the basis of an understanding of the natural world. Each conclusion is merely the best hypothesis to fit the available data. When the debate has strong economic, national security, or health implications, the problems become long equations with many variables, only a few of which may be scientific or technical in nature. High-level nuclear waste, for example, will not be buried under Manhattan, no matter how suitable the geology. As scientists, we are called upon to find the best solution that fits within political, social, and economic boundary conditions. As the boundary con- [illegible] value judgments, we remain outside the mainstream of the decision-making and allow policy-makers to set the course while we criticize from afar. The arguments we constructed for the scientifically illiterate now sound self-serving, and we find ourselves among the followers of change rather than the leaders.

Why are the head of the Environmental Protection Agency, the Ambassador to Kazakhstan (a country with concerns over earthquakes, oil reserves, and nuclear contamination), and the chairman of the House Science Committee not scientists? Why are we not [illegible]

It starts with universities, where success has historically been achieved through spe- [illegible] policy-making are frowned upon. Thus begins the vicious cycle: Bright students do not see [illegible]

Our long-term future depends on citizens understanding and appreciating the role of [illegible] lobbyist can make these arguments for us. In the next generation, we will need not only scientists who are experts in subspecialties, but also those with a broad understanding of science and a basic literacy in economics, international affairs, and policy-making. In the end, our greatest threat may not be the scientific illiteracy of the public, but the political illiteracy of scientists.

Gregory E. van der Vink

[illegible]

economy, whose feasible solutions do not depend upon the included contributions of scientific and technological progress.

Furthermore, although we should have learned from experience a great deal about forseeing the possible economic benefits of fundamental discoveries of physical principle, most of the actual benefits depend upon the ingenuity of entrepreneurs and their associates in finding appropriate, added uses of fundamental science's discoveries of principle. Thus, in real economics, scientific progress is a good per se.

So, self-defined economics-illiterate van der Vink deludes himself if he imagines that a scientist's "basic literacy in economics" would bring that scientist around to van der Vink's view.

A Fraudulent Definition

Finally, on a still deeper level, the entirety of *Science*'s editorial is a fraud respecting its definition of science as such.

The idea of science was first posed by Plato and his collaborators and followers of the Academy of Athens. This included Plato collaborators such as Theaetetus and Eudoxus, such followers as Eratosthenes, and such contemporaries and collaborators of Eratosthenes as the famous Archimedes. The center of the Socratic method, from which the notion of science was derived by Plato, is the notion of *agape,* the passion for justice and truth for their own sake, the same notion famously presented afresh by the Apostle Paul's *I Corinthians* 13. Anyone who has either generated a validated discovery of principle, or, who, simply replicated the mental experience of such a discovery, is familiar with that special quality of passion, *agape,* upon which depends the possibility of the concentration indispensable for solving the true paradoxes of experimental physical science.

The very notion of a validatable discovery of universal principle, overturning the inadequacies of previous scientific belief, typifies the fact, that it is the true nature of science, to refute and overturn previously established opinions, not to pander to them. Within the history of science itself, this is always accomplished through the efforts of a small minority, over the stubborn resistance of the majority of the profession.

The *Brotgelehrte* may, and probably will protest this, and, that, probably, with a quality of indignation otherwise evoked by dousing a professional barnyard hen. The fact of the matter, is that a culture whose prevailing public opinion defies discoverable laws of the universe, has earned calamities, if not outright extinction. In the conflict between truth and public opinion, the composition of our universe predetermines, that it is truth, not prevailing opinion, which, in the end, must necessarily win. In that sense, both van der Vink and *Science* magazine have already lost this argument.

Economist Lyndon H. LaRouche is a member of the scientific advisory board of 21st Century, *and writes frequently on science and science history.*

Notes

1. Gregory E. van der Vink, "Scientifically Illiterate vs. Politically Clueless," *Science*, Vol. 276, No. 5316, p. 1175.
2. The author is identified as "director of planning at the Incorporated Research Institutions for Seismology in Washington, D.C."

Letters

continued from page 4

on Mars on July 4, or that we never landed astronauts on the Moon.

Weber's Aphorisms And St. Augustine

To the Editor:

I just read the "Aphorisms" by Wilhelm Weber, translated by Jonathan Tennenbaum, in the Summer 1997 issue. They reminded me of something that St. Augustine wrote around the year 400, the *Confessions.* The 11th book of that volume is dedicated precisely to a philosophical discussion of what is time.

Augustine's conclusions are similar to those which Weber reached. This is particularly clear in paragraphs 11 to 26 of the 11th book. Perhaps your readers would be interested in looking at this, as a follow-up to the Weber "Aphorisms."

Leonardo Servadio
Milan, Italy

Protein Vs. Carbohydrates

To the Editor:

Whoever wrote the articles in the Special Report, Summer 1997 ["We *Can* Feed the World"] has little experience with farming, and even less knowledge of nutrition. No doubt they are followers of the calorie theory, which is fine for the feeding of laboratory animals, but is of no use in the feeding of humans.

As for what genetics has done for our grains, consider this: When I was a boy in the 1920s, Kansas wheat would run 18 percent protein, and the best of it would be 28 percent protein. Today, for all the improvements in the wheat breeding, Kansas wheat now runs 12 percent protein, and the best of it will go to 18 percent. The same problem comes up with corn. About World War I, field corn analyzed from 9 percent to 10 percent protein. Today, the corn will run near to 4.5 percent to 5 percent protein. Even with the increased yields in bushels, the amount of protein produced per acre is no better now than it was 50 years ago. . . .

The crucial problem in food is the protein content. The feeding problem in the

Continued on page 82


Sandia National Laboratory

Electrical discharges illuminate the surface of the Z machine, the world's most powerful X-ray source, during a recent accelerator shot.

SANDIA DEMONSTRATES TECHNOLOGY FOR DRIVING FUSION ENERGY

In July, scientists at the Sandia National Laboratory in Albuquerque, demonstrated that their Z accelerator is capable of driving inertial confinement for the production of fusion energy. The accelerator, which is comparable to a scaled-up Leyden jar, generated a 210-trillion-watt pulse of X-rays from an input 50-trillion-watt electrical pulse. These X-rays can be used to implode minute fusion fuel pellets to the high densities and temperatures needed to ignite nuclear fusion reactions. As in Benjamin Franklin's apparatus, the Sandia "Leyden jar" is discharged into wires. But this pulse is far greater—millions of volts and tens of millions of amperes of current. In July the accelerator achieved temperatures of 1.5 million degrees C by this method, close to the 2 to 3 million degrees needed. In the preceding 10 months, breakthroughs had enabled the machine to more than quintuple its output to this level. Three hundred thin wires form a cylindrical configuration the size of a thimble, in which the fusion fuel pellet is to be placed.

INDIA'S EXPERIMENTAL FAST BREEDER REACTOR JOINED TO POWER GRID

India's experimental Fast Breeder Test Reactor (FBTR) was formally joined to the power transmission grid on July 12, working at 11 MWt. Placid Rodrigues, director of the Indira Gandhi Center for Atomic Research (IGCAR) at Kalpakkam, in the state of Tamil Nadu, termed the latest success a historic achievement that will pave the way for the country's first 500-MW prototype fast breeder reactor, a step toward developing commercially viable breeder reactors domestically.

CFC REPLACEMENTS IN AIR CONDITIONERS CAUSE LIVER DAMAGE

Workers in a Belgian factory suffered liver damage from air conditioners that were leaking hydrochlorofluorocarbons (HCFCs), replacements for CFCs. Nine workers at the same plant were diagnosed with acute hepatitis, according to the Aug. 23 issue of *The Lancet,* the British medical journal. The CFC replacements, HCFC-123 and HCFC-124, were known to be highly toxic, unlike the now-banned freon—which is virtually harmless—but were rushed into production without the usual testing that chemical products such as pesticides are required to have.


NASA

Crista-Spas, the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (Crista), housed on the Shuttle Pallet Satellite (Spas), is shown here in a check-out phase on the robotic arm of the Space Shuttle.

CRISTA-SPAS SHOWS NO OZONE CRISIS, GERMAN DAILY SAYS

There is no ozone hole crisis, according to data from the Crista-Spas experiment taken aloft by the Shuttle in December 1994. This is the message of an Aug. 10 article, "Is the Ozone Hole a Fiction?" in the German daily, the *Hessische-Niedersächsische Allgemeine Zeitung,* occasioned by the second lofting of Crista-Spas by the Shuttle in August 1997. An analysis of the earlier Crista data, which was the cover story of *21st Century,* Spring 1996, showed that meteorological, not chemical, processes determine the appearance of ozone holes. The data from Crista make it possible, for the first time, to construct a continuous picture in three dimensions of ozone density between heights of 15 and 70 kilometers.

The newspaper article, by Sepp Spiegl, quotes Prof. Klaus Grossmann, of the University of Wuppertal, who heads the Crista-Spas experiment: "Data about the ozone layer [prior to Crista] come from about 40 stations around the world. If you simply extrapolate these data . . . you have a pretty good guarantee to be completely off with your computer models. Also, current satellite devices measure in so spotty a fashion, that structures such as actually exist in the ozone layer cannot be found." If the 1994 Crista data are confirmed by the new flight, Spiegl says, "environmentalists, scientists, and above all politicians, around the world, must throw overboard their climate models, ozone hole theories, and especially their long-range forecasts."

POPULAR SCIENCE BLAMES OZONE BACKLASH ON _21ST CENTURY,_ LAROUCHE

The October issue of *Popular Science* magazine features an article that laments the "still raging" debate over the ozone-depletion theory, and credits *21st Century* and Lyndon LaRouche for this continuing "ozone backlash." The article, "Attack on Ozone Science" by Arthur Fisher, opens with the fact that pickets from the "Schiller Society" (actually the Schiller Institute) greeted F. Sherwood Rowland, inventor of the ozone-depletion theory, when he arrived at the Stockholm Concert Hall in December 1995 to receive his Nobel Prize for Chemistry. The rest of the article is a rehash of Rowland's and the Environmental Protection Agency's propaganda, highlighting, in red type, the skin cancer scare story. The main line of Fisher's argument is the claim that the majority of scientists agree with Nobel Prize winner Rowland and other "Nobel Prize-caliber" scientists! How is it, he asks, that a "tiny majority of scientists has managed to keep alive the ozone debate?" Fisher quotes Steven Schneider saying that the problem is the tactic of "arranging what seems to be an even-handed presentation," with both sides being heard.

Popular Science: What's popular is science?

CHINA ASKS UNITED STATES: PLEASE EXPORT NUCLEAR POWER!

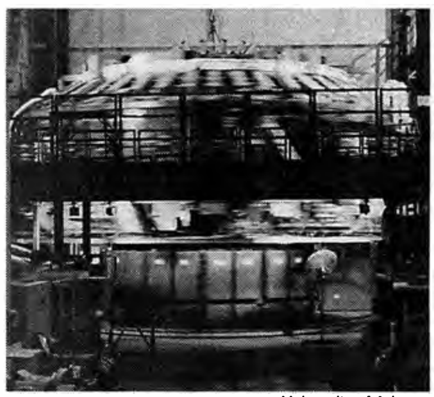
During preparations for the fall summit of Presidents Bill Clinton and Jiang Zemin, Beijing urged the United States to lift sanctions on sales to China of nuclear equipment, digitally controlled machinery, and other advanced technology. "There is a 'shortcut' to quickly enlarge bilateral trade. That is to eliminate the exports sanctions towards China," according to Zhou Shijian, an expert on Sino-U.S. ties, quoted in *China Daily's Business Weekly,* Aug. 17. "U.S. companies are competitive in both technology and price, but they lack these opportunities," Zhou said, referring to the sanctions. Since 1989, China has bought or contracted for about $8 billion of nuclear reactor equipment from France, $3 billion from Canada, and $4 billion from Russia, Zhou said. (See this issue's Special Report, p. 10, for more on China's nuclear energy plans.)

GHOST OF GALTON: _NATURE_ PROMOTES HERITABILITY OF IQ

A new statistical analysis of familial IQ correlations is promoted in a commentary in the July 31 issue of the British journal *Nature,* arguing that intellectual ability is largely determined by genetic influences ("The Democracy of Genes," by Matt McGue, University of Minnesota). The study, by B. Devlin, M. Daniels, and K. Roeder, in the same issue of *Nature,* compared data on twins separated at birth with those raised in the same household, and concluded a "broad-sense heritability estimate" of 48 percent, and a "narrow-sense heritability" of 34 percent. Such claims by eugenicists were most recently discredited when similar studies at Harvard in the late 1960s by Arthur Jensen and Richard J. Herrnstein were shown to rest on fraudulent data. McGue praises the 19th century British founder of the modern eugenics movement, Sir Francis Galton, noting that this racialist was also a founder in 1869 of the journal *Nature.*

LARGE BINOCULAR TELESCOPE MIRROR CASTING NEARLY COMPLETED

The temperature in the oven where the Large Binocular Telescope's first mirror blank is being cast reached 44°C on Sept. 1, and the expected date for peeking into the oven is Sept. 10, with a more ceremonial opening on Sept. 12. After the initial cooling was complete in April, additional glass was added to compensate for unexpectedly large leaks, and there was partial reheating to fuse the new glass to the old. John Hill, director of the Large Binocular Telescope project at the Steward Observatory Mirror Lab, told *21st Century,* "If it is in one piece, we will declare victory." Readers can get an update at http://medusa.as.arizona.edu/lbtwww/lbt.html, and a story will appear in the next issue.

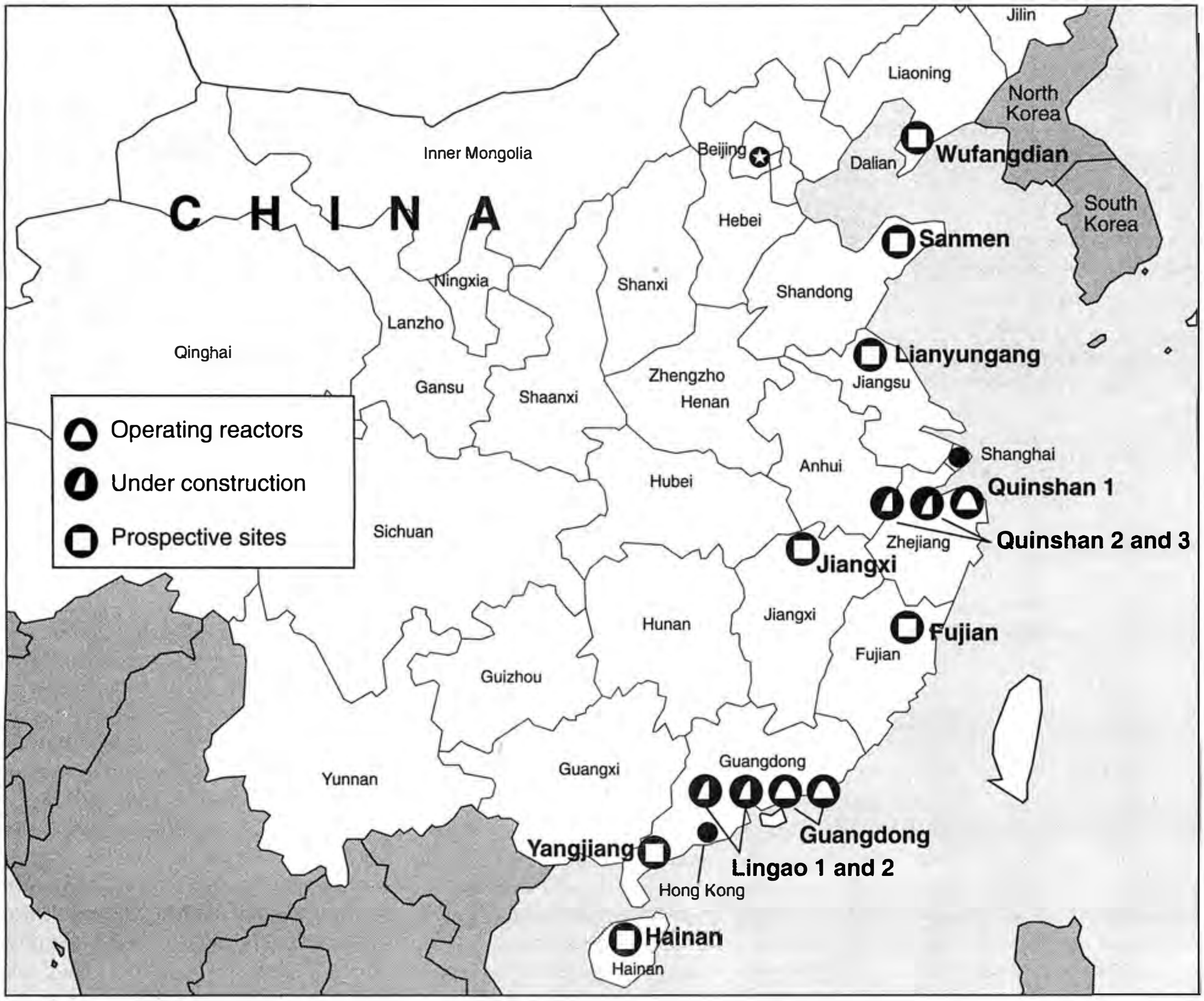


University of Arizona

The mirror oven at Steward Observatory Mirror Lab spins, to produce a paraboloid surface on the molten glass.

China Is Going Nuclear!

by Jonathan Tennenbaum



NUCLEAR POWER IN CHINA

China's nuclear construction plans include two 600-MWe units at the Qinshan site, two 950-MWe units at the Lingao site, near the existing Guangdong plants. Other sites under discussion are two 1,000-MWe plants, in cooperation with the Russians, at Wufangdian, and possible sites in Jiangsu and Fujian provinces, in cooperation with the South Koreans. Provincial projects under discussion include one unit on the island of Hainan; up to four units in Jiangxi; two or four units in Zhejiang; and two units in Jiangsu at the port city of Lianyungang.

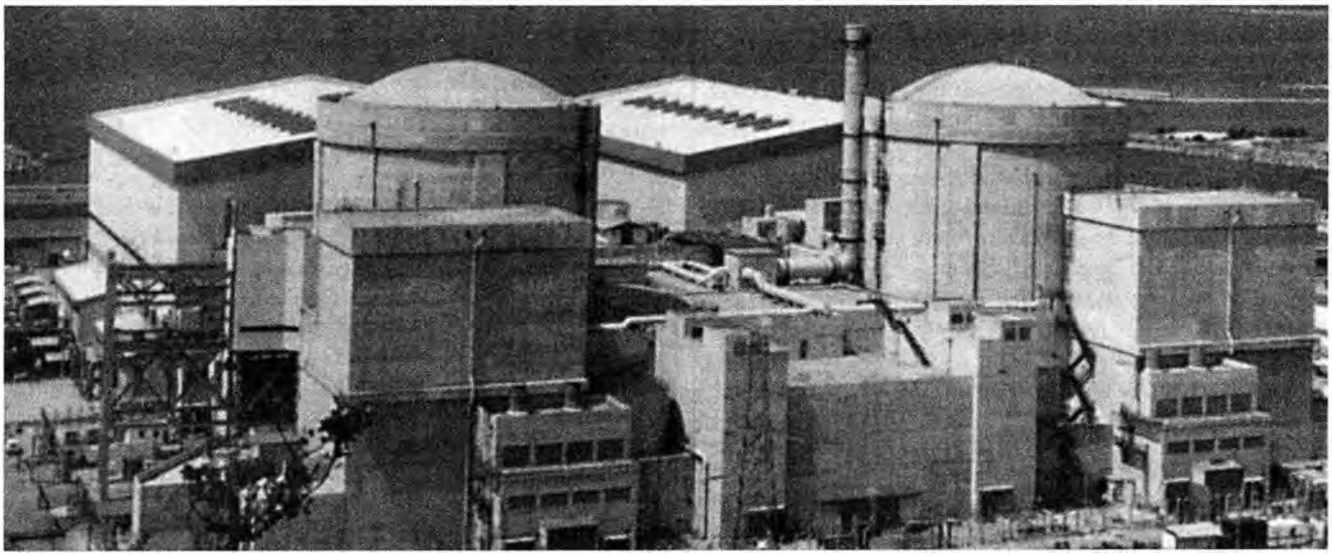
Coal is now the chief source of energy for China's economy. Although China has large reserves of coal, the enormous costs of mining, transporting, and burning more than 1.3 billion tons of coal every year—in terms of direct economic cost as well as costs associated with pollution and other side effects—dictate the urgent need to develop nuclear energy as the decisive option for the future.

China's own capabilities in the field of nuclear energy were initially developed in connection with military projects. Although plans to build nuclear reactors for civilian power generation go back to the early years of China's

Continued on page 15

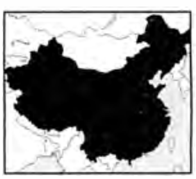
INTERVIEW WITH DR. RONALD L. SIMARD

China's Nuclear Program Has Tremendous Potential for the U.S.



UNDP

China's Guangdong nuclear plant at Daya Bay. The first two Guangdong units were begun in 1986, with the participation of Hong Kong, France, and the United Kingdom.



Ron Simard is the Director of Suppliers and International Programs for the Nuclear Energy Institute, the U.S. trade association of the nuclear energy industry. He has 25 years of experience in the commercial nuclear power industry, and is responsible for managing issues that concern maintaining an international leadership role for U.S. nuclear technology.

Simard was interviewed by Associate Editor Marsha Freeman in July.

Question: At a press conference on May 29, Marvin Fertel, vice president of the Nuclear Energy Institute, discussed the potential for U.S. nuclear exports to China. Would you go through some of the history, and explain what obstacles U.S. companies face now in selling nuclear reactors to China?

There are two obstacles, both legislative: a 1985 Congressional resolution and a 1990 act. Congress said in those two items that before trade with China in the nuclear area can resume, the President must make some certifications. The President has to send a report to Congress that says, basically, the Chinese have assured us that they are not going to transfer the materials that we provide them to a third country, that they're going to act in accord with non-proliferation agreements, and so forth. So, to change the situation, step number one is, that the President forward this certification to Congress; and step number two is, that if Congress takes no action, after 30 days of continuous session, then the current restrictions are lifted.

Question: Since 1985, has any President submitted this certification report to the Congress?

No. Currently, the administration and the Chinese are involved in negotiations and, according to the Department of State, China has made considerable progress toward some of the agreements and principles that are at stake here. If that progress continues, there is a chance that the President will be able to make the necessary certifications by the fall of this year.

Question: At the current time, China has only about 2,000 MW of nuclear capacity. Can you describe what the Chinese are planning in terms of increasing their nuclear capacity, and why this is an important question for the United States?

You probably understand what is driving them to consider nuclear—the problems they've got with where their coal is located, where their hydro is located, and where they need the electricity the most. On the basis of their planned economy, they have specific commitments. As you said, they have 2 gigawatts (GW) in operation today. By 2010, they are committed to have 20 GW of nuclear.

Let me give you three dates to put this in perspective. The Chinese are committed to have 20 GW by 2010. In the following 10 years, by 2020, they are going to raise that two and a half times, to 50 GW. And then, in the following 30 years, to 2050, they are going to triple it, to 150 GW.

That's a tremendous growth. Even the United States in the 1970s, and France—which relies on nuclear energy for about 80 percent of its electricity—didn't expand that quickly. There is tremendous potential there for the United States, not only in terms of trade, but also in terms of being able to influence the safety and reliability of these plants.

Question: When the Chinese Minister for Science and Technology was in the United States earlier this year, discussing Chinese plans for building nuclear power plants, he mentioned their work with the French, Canadians, and the Russians, and then said, "But really what we would like is U.S. technology."

What do we have to offer the Chinese in terms of the new generation of nuclear reactors developed here?

The NEI had the press briefing in May because we had reached a major milestone here. Today we have 109 plants, with wide variations in both design and the way they are operated. They are all running safely—if they weren't, the Nuclear Regulatory Commission (NRC) would shut them down. But any time that a potential safety issue comes up, one of the first things that the industry and the NRC have to do is determine whether that particular problem exists at each one of these plants, because of the variety of designs and operation.

What we have done for the future is standardize three designs, and we have already completed a significant amount of design detail. We have some thirty 3-inch binders—3 feet worth—that describe the design detail that has been reviewed and approved by the NRC. In addition, there is a stack of detailed system drawings that must be about 3 or 4 feet tall.

"The Chinese are committed to have 20 GW nuclear by 2010. In the following 10 years, by 2020, they are going to raise that two and a half times, to 50 GW. And by 2050, they are going to triple it, to 150 GW."

What we have to offer the international markets—right now—is an essentially complete design, where the safety issues have already been reviewed and approved, and where there is a demonstrated margin of safety about 100 times greater than the plants in operation today.

The second thing we have to offer them is this concept of standardization, the fact that the design details are locked in by the NRC in terms of rule-making, so they will remain standardized across the first plant, the second plant, the eighth plant. Eventually, when we've built the tenth plant, these plants will be nearly identical in their design as well as in their operations. So there will be a tremendous advantage in assuring safe operation, in terms of regulating safety, and in terms of the economics of being able to run these plants.

These plants will be much more cost competitive, in terms of being able to share the same procedures, the same plant simulator for training, the same crews of people to go from one plant to the other to do refueling outages. Those are the advantages the Chinese see to our designs.

Question: Is there a projected gain in efficiency, in addition to safety?

The reason we see an improvement in that area is because it was designed in from the beginning. About 15 years ago, a group of U.S. utility executives got together to look ahead to when they thought they might need to reconsider nuclear plant orders, when there would be a need for new generating capacity. They started to think of the problem from the point of view of the customer, the utility industry, and they developed what is called "utility requirements."

So right from the beginning, the utilities, the future customers, told the plant designers that they wanted assurances that these three new plant designs would meet detailed specifications: They wanted assurances that this plant could be built in three-and-one-half years (for the 600-MW passive design), or four-and-one-half years, for the bigger plant designs. They had specific and detailed (three binders' worth) requirements on safety, economic performance, and so on. So, the plant designers started from those basic specifications as they began working out the design details.

The other thing that is key to the evolution of these designs, is that the utility executives set up a committee, through the Electric Power Research Institute, and that committee has been meeting with

NUCLEAR ENERGY MARKET POTENTIAL IN CHINA

Plant	Size (MWe)	Province	Completion/Status
Under construction or in advanced negotiations			
Qinshan 2,3	600	Zhejiang	2001-2002
Lingao 1,2	985	Guangdong	2002-2003
Qinshan 4,5	740	Zhejiang	2004-2005
Lianyungang 1,2	1,000	Jiangsu	2005-2006
Proposed stations			
Lingao 3,4	1,000	Guangdong	Site expansion
Yangjiang 1-6	600 or 1,000	Guangdong	New site
Sanmen 1,2	700-1,000	Zhejiang	New site
Fujian 1-4	700-1,000	Fujian	Pre-feasibility study
Shandong 1-4	700-1,000	Shandong	2004-2010
Jiangxi 1-4	1,000	Jiangxi	Pre-feasibility study
Jiangsu 1,2	700-1,000	Jiangsu	2001-2005
Hainan 1,2	700-1,000	Hainan	Pre-feasibility study

Source: Nuclear Energy Institute

the designers three times a year for the past 15 years. At every meeting, the designers report on where they are. They may say: "we have finished the spent fuel pool system. Here is the verification that the design meets your requirements." So there has been a steady iteration and ongoing process between the designers of these plants and the ultimate customers, to make sure that the design was driving toward the requirements that we had put in for safety, reliability, economics, and other measures of performance.

Question: It may not be obvious to people why China—which is a developing country even though it is one of the few nuclear weapons states and launches its own rockets and missiles—would be going ahead with nuclear power at the pace that you mentioned. China sees itself as a centerpiece of a series of projects involving more than a dozen countries in Asia, Central Asia, and into the Middle East, described as the Eurasian Land Bridge, looking back in history at the old Silk Road, to connect the Pacific to the Atlantic.

China is starting with transportation, such as completing and extending regional railroad projects, but envisions the construction of whole new cities along the Silk Road. The agriculture and industry, along with the new cities, will require tremendous amounts of energy, and specifically, electricity. So it would seem that the Chinese are determining their need for energy in the future based on this plan for broader economic development. Have you discussed this larger economic project with any of the people you have been talking to in China?

Only with respect to the point that you touched on. This kind of growth is going to require a *huge* increase in the use of electricity. There are so many interesting facts about China's current condition and its planned growth, as you just mentioned.

If you take China and India alone, for example, if they were able to link up, as you suggested, and bring their gross national product just up to the level of Poland today, that would represent an increase in energy use that is equivalent to today's energy use by Japan, and Western Europe, and the United States. We're aware that they have tremendous plans in terms of growth, and there is a well-established link between growth and the use of electricity. The use of energy matches the growth of gross national product almost one-for-one. If you follow their line of reasoning, you recognize their plans for growth, you understand why they are going to need more electricity. Then, you get into what their options are. That helps you understand why they have got such an ambitious program in nuclear.

You mentioned the railroad infrastructure. Today, China is the world's largest producer and user of coal. The problem is, most of their coal is in relatively remote areas, and about 40 percent of the railroad track in China is used for transporting coal. When you look around the country, and where the growth will occur—where the electricity will be needed the most—you are looking at the southeast and coastal regions, which are far from coal resources. Nor do they have the pipeline infrastructure to get natural gas there. You can begin to understand why China is relying so heavily on nuclear energy.

"What concerns us is that if the United States doesn't act soon to open up the market, the Chinese will move to standardize on a design, and it won't be ours."

Those areas are very heavily polluted now, and nuclear gives them the clean energy that they would not have if they went to coal or oil. If you look at the world's 10 most polluted cities, three of them are Chinese. There are some 500 major Chinese cities that don't meet the World Health Organization guidelines on clean air. So they are motivated, too, by concerns about their environment.

You're beginning to see in some of the cities in China, like Beijing—and also in Tokyo—kiosks on the street that will sell you fresh oxygen. You can actually get a whiff from a facemask of pure oxygen for a few cents! I think you are right on target when you point to their ambitious plans for growth, which requires electricity, which requires the use of coal where they can, hydro where they can, and nuclear, where it's appropriate.

Question: Periodically there are accusations in the press that China is giving various kinds of weapons and military-related material to countries that we may not approve of. Is the trade constraint very specific, applying only to nuclear material China is buying from the United States, or does it have a broader application, in China's having to meet non-proliferation requirements in other areas?

The concern that led to these trade constraints relates to nuclear proliferation. For example, there is the July 1985 nuclear cooperation agreement, titled, "The Agreement for Cooperation Between the Government of the United States and the Government of the People's Republic of China Concerning Peaceful Uses of Nuclear Technology." Congress approved that agreement, but passed a resolution in December 1985, which says, first of all, that any transfer of nuclear technology under that agreement would be solely for peaceful purposes.

Then, the resolution talks about the broader point that you mentioned, that China must provide assurances that it is not engaged in the "prohibited transfer of nuclear weapon technology to a non-nuclear weapon state." There have been concerns about China's transfer of chemical weapons and missile technology, but the restrictions that we are talking about, that keep us from exporting our advanced reactor designs, are specific to the peaceful use of nuclear energy.

Question: How did the 1991 legislation change the stipulations from 1985?

It expanded on it. The Foreign Relations Authorization Act was passed in 1990. Because of concern over what had happened at Tiananmen, there were six restrictions placed on trade with China. Five of these dealt rather broadly with financing and issuing of export licenses for military products, but the sixth was specific to nuclear. Again, it requires that before we could resume trade in nuclear materials with China, the President would have to certify to Congress that China has provided clear and unequivocal assurances that it is not assisting any non-nuclear-weapon states in acquiring nuclear devices. It's similar in intent and language to the 1985 resolution.

Question: Many of these questions are very technical and there will be an amount of judgment in determining whether countries are adhering to vari-

ous treaties. It seems to me that the Clinton administration has made it very clear that its policy toward China is one of engagement, and that there will be areas where the United States and China will disagree, and will agree to disagree, but other areas where they will work closely together. This is really not that different from our relationship to Russia, in many ways. One potential area for cooperation is in the economic sphere.

In his press conference, Mr. Fertel stated that there was significant progress that the U.S. administration had seen in China's addressing non-proliferation concerns. If this progress were to continue, he said, "we're hopeful that when the President of China and President Clinton meet this fall for their summit meeting, the President will be prepared to make all the certifications to Congress, that will then allow the 1985 agreement to become effective. Our target is either this fall, or, if things are not wrapped up by then, the summit the following spring that will take place between the two heads of state, in China."

Is there any update? Will this be on the agenda in the fall for the meeting between the two heads of state?

We understand that they are still on track. That is the target they're working toward. You said that there are some subjective judgments that have to be made. You're right to some extent, but, actually, there is a pretty fair amount of objective data that the President can point to. Remember, the resolution and the legislation that we were talking about go back to 1985 and 1990.

Since then, in 1992, China joined the treaty on non-proliferation of nuclear weapons. So, separate from any interactions that the Chinese have been having with our State Department and people in the administration, within the worldwide community, they are participating through the International Atomic Energy Agency in all the international nuclear safeguards agreements, so there is a pretty good record of progress that the administration can point to, since these two sanctions were put in place in 1985 and 1990.

Then, specific to what the President needs to certify, the administration continues to talk to the Chinese, getting the data that they need to provide the reasonable assurances [on non-proliferation], and from all we hear from the people involved, China has provided some pretty significant evidence, and still seems to be on track.

IAEA

Chinese nuclear specialists brief an Operational Safety Review Team of the International Atomic Energy Agency during a visit to China's Qinshan nuclear power plant, the nation's first.

Question: What does the United States have to do in terms of financial policy, such as the Export-Import bank, or other ways to make it easier for China to buy U.S. nuclear technology?

I'll give you one example. If you go back to the legislation from 1990, as I mentioned, there were six specific restrictions on trade with China. One of those has to do with issuing any new insurance or reinsurance, providing any loans or guaranteeing any financing or any other kind of financial support with respect to the People's Republic of China by the Overseas Private Investment Corporation. One specific thing that the United States would have to do, is that when the President certifies to Congress that China has met the non-proliferation conditions, he also has to address these five other restrictions that were in that Act, including this one on financing of nuclear projects.

The President has two choices. First, he can report to Congress that it is okay to lift those restrictions because China has made progress on a program of political reform, and that is what was driving Congress after Tiananmen. Or, the President can waive those restrictions in the national interest.

Question: There are many possibilities for more advanced nuclear technology to be developed. One of the most promising is high temperature reactors, where the waste heat that does not go into electricity production can be used for industrial and other applications. Are the Chinese looking at these new nuclear technologies? Are we cooperating with them in any R&D?

I think they probably are looking at high temperature gas-cooled reactor concepts. I know that they have at least one research institute that is looking at a number of options. I can tell you that the United States is not interacting with them on such a program. The support for that here has vanished. Congress deleted all funding for further development on that reactor concept from the appropriations bills last year, so the United States has no effort to develop that concept any further.

Question: What other countries in Asia are you looking at, for the export of nuclear technology?

We certainly are interested in the Asian market, overall. The Japanese are also interested in our technology, and are, in fact, building it. They have two of the advanced boiling water reactors in commercial operation now, they have reasonably firm plans for building several more, and there are some in the stages between feasibility studies and initial bids. The U.S. industry is very interested in interacting with Japan, and, of course, the Koreans are building something that looks very much like one of the other standardized designs.

What concerns us with China is the timing. The Chinese recognize the benefits of standardizing on one design. They have been very good at negotiating financial arrangements with the Canadians and the French and the Russians. But they realize the problem they have trying to operate five or six completely different designs. What concerns us is that if the United States doesn't act soon to open up the market, the Chinese will move to standardize on a design, and it won't be ours. We have what are arguably the safest nuclear designs in the world today, and we're worried that if the resumption of nuclear trade is not soon, China won't have access to that.

China Is Going Nuclear

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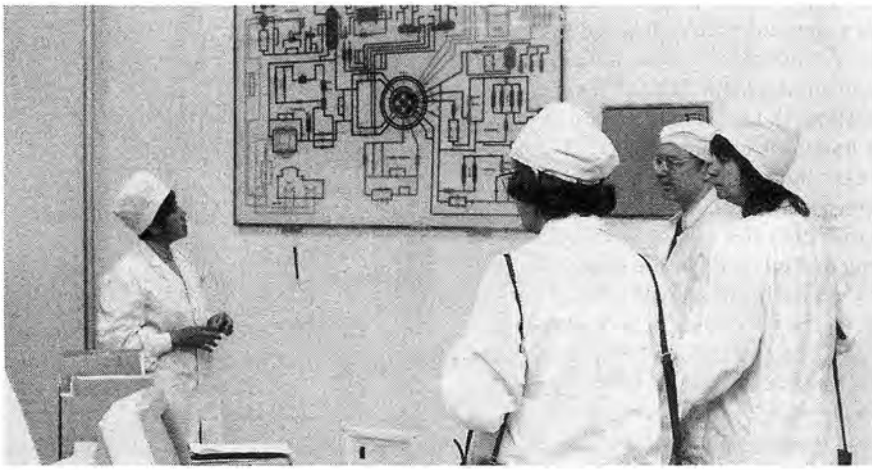


Schiller Institute

Author Tennenbaum (second from right) and Schiller Institute representatives Helga Zepp LaRouche and Mary Burdman tour the Nuclear Technology Institute of Qinghua University, where China's High Temperature Reactor is being built. Here, a project leader explains the construction of another Chinese nuclear project, a reactor for district heating and desalination applications.

nuclear program, the first full-scale civilian reactor project followed on the heels of the initial economic and political reforms of Deng Xiaoping in 1978-1979. This resulted in the construction and successful operation of the 300-MWe Qinshan nuclear power station, on the basis of domestic technology developed by conversion of military-industrial potentials.

Although the Qinshan station has provided impressive demonstration of China's own capabilities, China emphasized the acquisition of foreign technology for its next big reactor projects. The first such major project was the Daya Bay nuclear station comprising two reactor blocks of 930 MWe each, completed in 1994 largely by a consortium of Western companies with France playing the leading role. Contracts have now been signed, by the same consortium, to build a second nuclear plant of two 985 MWe units, not far from the original Daya Bay location, near Hong Kong in the South of China.

In addition, negotiations between China and the Atomic Energy Commission of Canada, are already far advanced, for the construction by Canadian companies of a nuclear power station with two 700-MWe units, based on Canada's CANDU technology. Furthermore, China and Russia are negotiating a contract for construction of a large (possibly four units of 1,000 MWe) nuclear power station near the port city of Lianyungang, in Jiangsu Province. Lianyungang is important as the chief "eastern terminal" of the Eurasian Land-Bridge railroad, running from China's east coast all the way to the Atlantic coast of Europe. China has expressed great interest in cooperation with the United States on further nuclear projects.

Other Chinese Designs

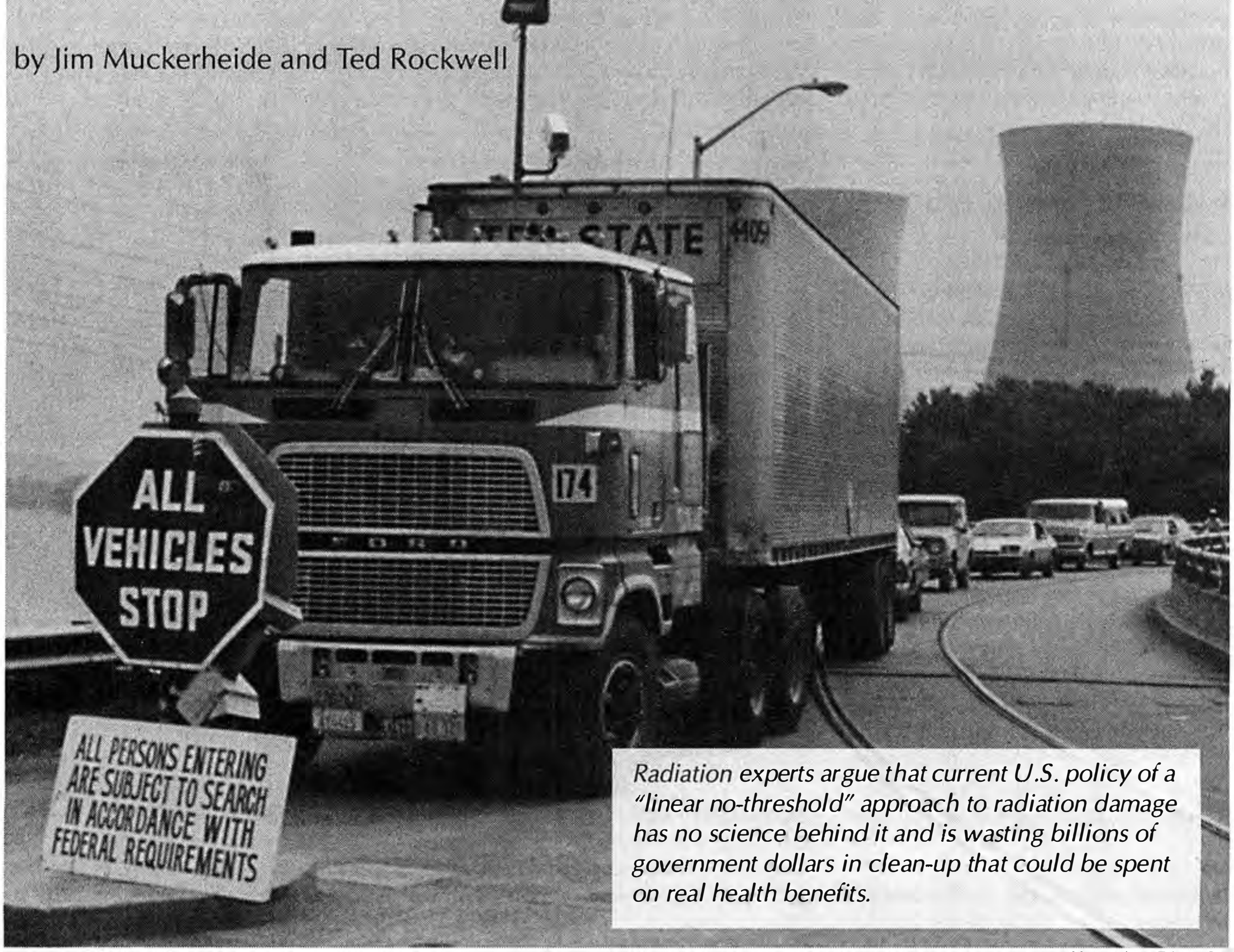
At the same time, China is pressing forward with its own nuclear projects. One of these is ongoing construction of a small-scale helium-cooled High Temperature Reactor (HTR) based on the German design with spherical fuel elements. This technology offers the advantages of "inherent safety," mass-producible modular design, as well as higher outlet temperatures (up to 1,000°C or more) suited for industrial process heat applications as well as the possibility of highly efficient electricity generation by means of a helium turbine in the primary coolant loop. The first Chinese HTR will go critical in 1999.

Also planned are a 200-MWt scale-up of China's own low-temperature heating reactor technology, suited for district heating as well as desalination applications, and construction of a fast breeder reactor. At the same time, it is expected that China will build additional nuclear power stations based on upgrades of the domestic technology used in the Qinshan plant. A list of more than 20 potential sites for future nuclear plants has been drawn up, and China's provinces are all eagerly vying to have nuclear plants.

Jonathan Tennenbaum heads the Fusion Energy Foundation in Europe and is working closely with the Schiller Institute on the Eurasian Land-Bridge project. His previous articles on China and the Land-Bridge appeared in the Special Report section of 21st Century *in Spring 1997 and Winter 1996-1997.*

The Hazards of U.S. Policy on Low-level Radiation

by Jim Muckerheide and Ted Rockwell



Radiation experts argue that current U.S. policy of a "linear no-threshold" approach to radiation damage has no science behind it and is wasting billions of government dollars in clean-up that could be spent on real health benefits.

Metropolitan Edison Co.

A shipment of low-level radioactive waste.

EDITOR'S NOTE

Jim Muckerheide is Massachusetts State Nuclear Engineer, and a member of the Governor's Advisory Council on Radiation Protection, under whose auspices a great deal of the data that contradicts current policy has been compiled. He also directs the Center for Nuclear Technology and Society at Worcester Polytechnic Institute, and is chairman of the Biology and Medicine Division, and the Low-Level Radiation Health Effects Committee of the American Nuclear Society.

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This article is based on the Radiation, Science, & Health policy statement provided in July 1997 to the President's Council of Advisors on Science & Technology for its review of U.S. energy research and development, and its impact on the economy, environment, and national security. RSH can be reached at Box 843, Needham, Mass. 02194, Tel./fax (617) 449-2214, or Email to rad-sci-health@wpi.edu

Government officials and scientists keep repeating that any amount of ionizing radiation, no matter how small, must be considered hazardous. This statement is not a scientific truth; in fact, it is contradicted by data from laboratory experiments and epidemiological analysis, and by basic biological theory.

Nevertheless, this statement, and the government policy based on it, are the sole justification for fantastic scenarios of single man-made radioactive atoms migrating for miles, through billions of naturally radioactive atoms in the desert soil, to contaminate water supplies millennia from now.

Such scenarios create needless fear, endless delays, and extraordinary expense, for harmless low-level waste storage. They are also the basis for a June 3, 1997, U.S. Department of Energy (DOE) report that 23 people will die from trivial doses of radiation as trucks of shielded radioactive waste drive across the country. In fact, such waste produces lower exposures to radiation than many naturally radioactive materials in everyday use.

Because of the fear created by this official policy, many people avoid life-saving medical techniques that involve radiation, and hundreds of billions of dollars are allocated to "decontaminate" locations that are well below the natural radiation levels where people have lived healthily for generations. If this harmful misconception were corrected, we could eliminate most of the problems of fear and cost that now constrain the use of nuclear technology.

History of a Bad Policy

How did such a bad policy come into being?

Despite repeated lowerings over the years of permissible radiation levels, the evidence is that the first radiation protection standards, recommended in 1934 by the National Council on Radiation Protection and Measurement (NCRP), provided adequate protection for the population. After World War II, data from the A-bomb victims, and irradiation data from mice and other animals, showed that radiation doses of more than about 500 rem from atomic bombs were generally fatal, while doses of less than 40 or 50 rem left no detectable short-term damage.

Because any cancer or genetic damage would not show up for several decades, it was argued in the 1950s that it would prudent to assume, for administrative purposes, that the detrimental health effects of radiation were roughly proportional to the amount of radiation received, and would continue in a linear relationship all the way to zero radiation exposure.

This is called the linear no-threshold (LNT) model of radiation damage. It gave rise to the concept of "as low as reasonably achievable," or ALARA. ALARA states that even when all other regulations have been met, one must lower radiation exposures still further, limited only by that ambiguous term "reasonable."

The Adverse Effects of LNT

The institution and use of the LNT model has several serious implications:

(1) No threshold radiation level is established below which exposure can be disregarded.

(2) Little account is taken of the adaptive response in human beings—repair, healing, and apoptosis (cell death)—that automatically takes place when radiation is received over an extended period of time, as in occupational or environmental exposure to radiation.

(3) The concept of "collective dose" was created, to apply to large populations exposed to low-level radiation. In this fiction, trivial individual doses are added up in a large population, to "predict" adverse health effects, and even deaths, in an exposed population—although there is no scientific validity whatsoever to support this concept.

Initially, regulatory concern was focussed on situations involving potential exposure to those higher radiation levels where health effects had been observed. Now, however, regulators and hazards analysts are increasingly applying the ALARA concept to radiation levels that are less than the natural radiation background, and also are far less than the variations in the natural radiation all of us encounter in daily living. The costs, direct and indirect, of this situation are immense.

Who Sets the Standards?

Both the U.S. Environmental Protection Agency and the Nuclear Regulatory Commission have some responsibility for setting radiation standards. And they, along with the DOE, Food and Drug Administration, and other Federal agencies, have extensively funded programs for research, analysis, and assessment of radiation health effects.

The EPA is now the lead federal agency on radiation standards, and recently the agency challenged the Nuclear Regulatory Commission's intention to set the decontamination limit (above which any radioactive contamination would have to be cleaned up) at a small percentage of the existing natural radiation background. The EPA argued for an *even lower limit,* citing linear-no-threshold-based calculations of *hypothetical* cancer deaths. The EPA brushed aside objections that the claimed health risks were fictitious, and that the increased clean-up costs would be enormous, and stated further that its position is not negotiable. If the EPA prevails, tax dollars will be spent to make slightly radioactive material slightly less radioactive. In terms of radioactivity, it will be lower than naturally radioactive granite, including that in New York's Grand Central Station, the U.S. Capitol, and many other buildings and soils.

Federal agencies acknowledge that they are all required to abide by the "consensus" of the scientific community, which Congress presumes will be determined and expressed by the BEIR (Biological Effects of Ionizing Radiation) Committees formed under the Board of Radiation Effects Research (BRER) of the National Research Council/National Academy of Sciences, as well as by the National Council on Radiation Protection and Measurements (NCRP), a private, non-profit corporation chartered by Congress for that purpose in 1964.

However, the independence of these bodies is compromised by their being led by, and dependent on, persons who are largely funded by those Federal agencies with an interest in maintaining current radiation protection regulations and "clean-up" programs. Most of the individuals involved have demonstrated allegiance, or at least acquiescence, to the LNT hypothesis and its derivatives. Such concerns support Federal programs and research funding.

In turn, these same organizations provide funds and support to the NCRP. The NCRP and BRER select their own members and appoint their own committees, which have become increasingly narrowed to persons known to favor, or at least accept, the current LNT, ALARA, and collective-dose philosophy of radiation control. The NCRP and BEIR Committees meet in closed session, without public participation, and do not publish records of their meetings. Their deliberations are not subject to peer review by the scientific community until after their formal reports have been released.

The substantial criticism of these reports in the scientific literature has been largely ignored by both the committees and the Federal agencies that apply the pronouncements justifying ever further reductions in radiation dose limits, and increases in public expenditures.

Deadly Consequences

The deleterious consequences of current radiation standards policy impose an immeasurable cost on society. Consider first some of the actions (and inactions) driven by unwarranted fear of low-level radiation. How does one measure the number of people who avoid needed mammograms, X-rays, and other lifesaving radiomedical techniques? Or the cost of 100,000 fear-inspired abortions in Europe in the year following the Chernobyl accident? Or lives lost because some people will not buy smoke detectors containing a radioactive source (which firefighters say are lifesavers)?

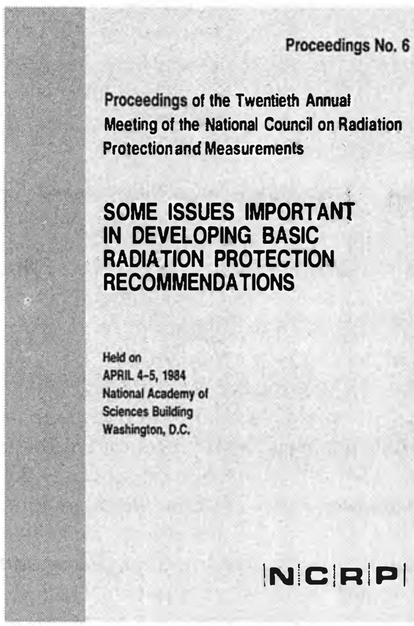
How do we determine the cost of burdensome regulations on handling radiomedicines, which have caused some hospitals to stop offering these lifesaving procedures, and which are pricing other radiomedicines off the availability lists of health maintenance organizations?

For some situations, there are available fatality figures. For example, about 10,000 people die each year, in the United States alone, from food poisoning, and the problem is growing in magnitude and complexity. The *New England Journal of Medicine* reported concern over this problem, May 29, 1997, and stated flatly in an editorial:

"We already have the means of virtually eliminating the problem—namely, irradiation. The use of ionizing radiation for food pasteurization has been extensively evaluated and is supported by the World Health Organization, the Food and Agriculture Organization, the International Atomic Energy Agency, and various other international agencies, scientists and government officials. Irradiation provides the greatest likelihood of substantially reducing bacterial and parasitic causes of foodborne disease associated with numerous foods. The time has come to use irradiation; we must not let any group use arguments without a scientific basis to keep such an important technique from the marketplace."

The 10,000 Americans who die each year from food poisoning are real persons, with names and families. They should not be sacrificed to save hypothetical persons, who are threatened only by baseless fears and a government policy that nourishes those fears.

Further, tens of thousands of Americans die each year from inhaling particulate matter, most of which comes from burning fossil fuels. This is in addition to the even greater health and environmental problems caused by SOx and NOx. Why do we burn fossil fuels instead of clean nuclear energy, and instead of saving these valuable chemical raw materials for future generations to make medicines, textiles, and other basics?


Proceedings No. 6

Proceedings of the Twentieth Annual Meeting of the National Council on Radiation Protection and Measurements

SOME ISSUES IMPORTANT IN DEVELOPING BASIC RADIATION PROTECTION RECOMMENDATIONS

Held on
APRIL 4-5, 1984
National Academy of Sciences Building
Washington, D.C.

NCRP

Although permissible radiation levels in the United States keep going down, the scientific evidence is that the first radiation protection standards, recommended in 1934 by the NCRP, provided adequate protection for the population. Here an NCRP report from 1984.

Why do we worry about shortages of water, our most abundant resource, instead of using nuclear energy to purify the oceans and pump the water wherever it is needed? (We have no problem with pumping millions of gallons of oil from the north slopes of Alaska to America's heartland.)

Much illness is caused by "sick buildings," made so by sealing them tightly in an effort to save a little energy. Is it more important to save energy than to keep people healthy?

We look everywhere to find the money to meet urgent public needs and curtail our national debt, yet we keep overlooking the hundreds of billions of dollars allocated to reduce radiation levels that are already harmless, and to study scenarios, and implement associated regulations and "decontamination" programs, based on nonexistent hazards.

Furthermore, the cost of nuclear technologies of all kinds—power plants, nuclear medical centers, critical research procedures—would be drastically reduced if we could eliminate much of the large, unnecessary effort now devoted to measuring, analyzing, accounting for, reporting, controlling, reducing, and disposing of *trivial* amounts of radiation and radioactivity, with no resulting benefits.

A Nuclear Absence

Consideration of nuclear power—its potential benefits and its associated problems and limitations—has been strangely absent from top-level meetings and daily press accounts of efforts to cope with environmental degradation. There seems to be wide agreement that burning fossil fuels must be curtailed, yet no one utters the dread word nuclear.

We have programs to help other nations with their energy problems, but we have specifically and inexplicably ruled out discussion of nuclear energy (except for the special case of North Korea, where we have taken the opposite stance). And until nuclear becomes a major energy source, the possibility of international conflict over the world's remaining fossil fuel supplies and the severe environmental consequences of their use, will escalate.

We cannot properly deal with energy and environmental problems, until this reluctance is overcome. We have to face the inescapable fact that the world will be increasingly dependent on nuclear power in the years ahead, even with a maximum use of wind energy and solar for those situations in which these technologies are appropriate. Although hydroelectric power is a proven power provider, on a global scale its potential contribution is grossly inadequate.

U.S. and international policy on low-level radiation feeds into the anti-nuclear movement's irrational fears of anything nuclear.

What Does Radiation Do?

The biological justification claimed for the LNT model, is that when a single ionizing photon or particle hits a living organism, it may damage DNA in the cell and this may impair the cell's function. But to understand the significance of this event, we have to look at the numbers of such events.

The first consideration is that we all live in a sea of natural radioactivity—natural sources of radioactivity impact our bodies with an average of 15,000 photons or particles every second—more than a billion such events every day of our lives.

But our bodies face even greater challenges: About 5,000 purine bases are lost daily from the DNA in each human cell because the body's normal heat breaks their linkages. Thousands of DNA nucleotides in each cell are also damaged each day by free radicals created in the normal process of metabolism, which results from routine eating and breathing. Our bodies continuously repair this damage with few mutations—unrepaired or misrepaired DNA.

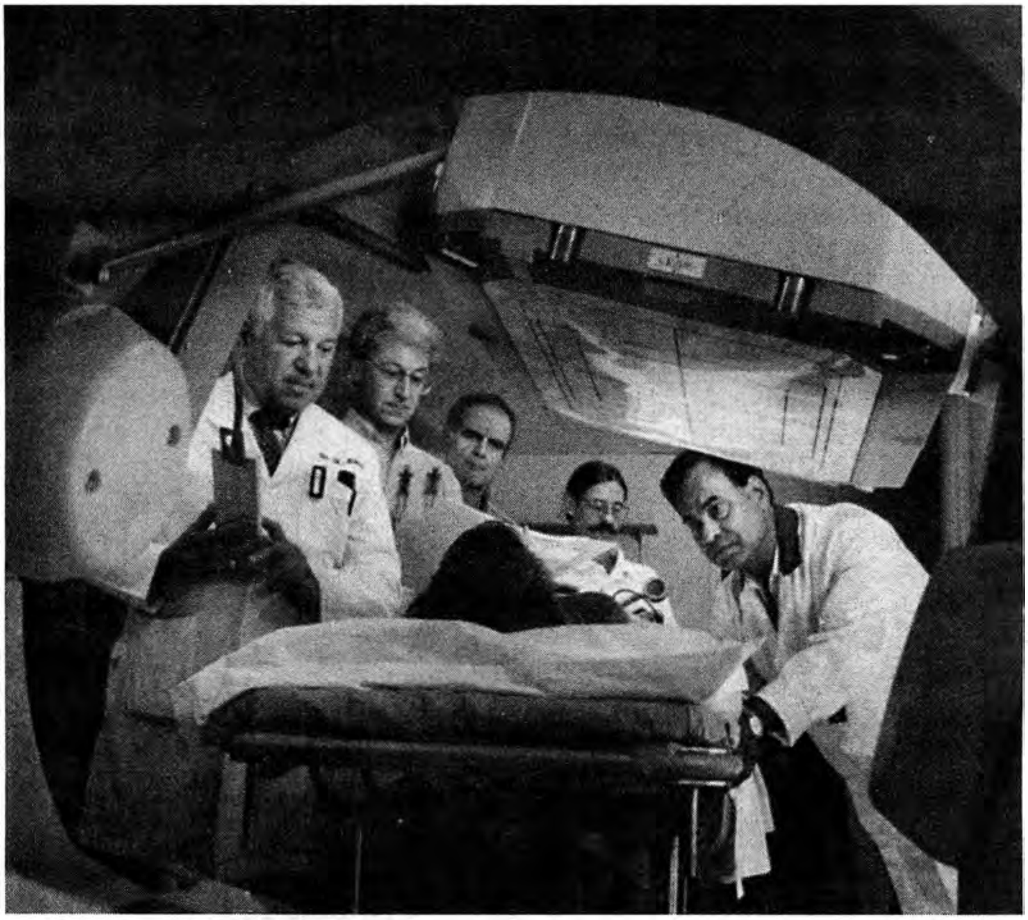
The resultant mutations from metabolism outnumber those caused by natural radiation by several thousand-fold. This is the case, even after making generous allowances for the fact that radiation causes more double breaks in the DNA than the normal metabolism does, and that these are harder to repair than single breaks.

These facts raise two questions: First, how can any living organism withstand such an onslaught—how do any of us survive? The answer is that the body has a large variety of enzymes that continually scan the DNA to repair damaged nucleotides. This results in such a high fidelity of DNA replication that our germ-line cells are subjected to only about 10 heritable mutations per year.

The second question is: What is the effect of low-level radiation that is not strong enough to degrade the body's tissue-repair capacity? The answer is suggested by the epidemiological evidence and by how the body reacts to low levels of other potential toxins: When we inject small quantities of disease bacteria into the body, the result is to stimulate the immune system, so that subsequent attacks by this toxin, in larger amounts, are effectively countered. This provides the biological explanation for the evidence that some positive health effects are seen in response to small increases in radiation doses.

Some research indicates that radiation may work just the same way. Numerous studies have shown that DNA and cellular repair mechanisms are stimulated by low to moderate levels of radiation. There are studies showing that organisms kept in a below-normal radiation background are affected adversely, and recover when returned to normal. (Note that we are not talking here about the potential damage from *high-level radiation.* High radiation levels can overwhelm the organism's normal biological functions and repair processes; they can leave the organism damaged, and vulnerable to the mechanisms that initiate cancer and progress to other adverse consequences.)

To summarize: Our body temperature and normal eating and breathing cause thousands more DNA mutations in our bodies than those caused by the natural level of ionizing radiation. In fact, the low-level radiation that is identified by current policy as being subject to regulatory consideration, is far below 1 percent of the average natural radiation background in which we all live. It is less than 0.1 percent of the higher levels of natural radiation below which more than 90 percent of the population now live. And there is evidence that populations exposed to higher background radiation experience some positive health effects.



Roger Stoutenburgh/Brookhaven National Laboratory

How many Americans have died because they feared to have medical treatments associated with radioactivity? Here, Brookhaven National Laboratory scientists use gamma imaging to check the spread of cancer to bone.

Suppression of Research

Disparities between the science and the governmental policy concerning low-level radiation have been demonstrated by numerous researchers for many years. But these reports have been systematically ignored and suppressed. Their proponents were often marginalized and de-funded, and many were driven from the field.

When the few remaining knowledgeable radiobiologists retire, there is no one to take their places. Research funding is always tight, yet significant funds are being provided to programs and persons committed to support the LNT model and to contribute to irrational fear.

Most workers in the field now go along with the prevailing view, or avoid situations where they have to take a stand. For example, researchers routinely "fit" their nonlinear data from experiments to a straight line that goes to zero on a graph. Even in the BEIR V report,[1] many examples are presented in which "there is no adverse effect below 40 rem," and yet the dose-response is reported as a straight line through zero.

Within the last few years, however, these disparities and contradictions have come to concern more and more scientists and policy-makers, not only because of the huge cost and the impact on other policy questions, but also because the process reflects poorly on the integrity of science itself. In the face of this professional concern, the NCRP set up a special Scientific Committee 1-6 to review the validity of the LNT and to recommend whether present policy should be revised. In addition, the National Research Council has convened two new BEIR committees, one to consider whether it should instigate a full-scale review of the LNT model (BEIR VII), and the other to consider revising current policy on radon (BEIR VI).

These deliberations are now under way. However, on the evidence to date, we remain concerned about the integrity of these efforts. Specific, high-level attention is required to ensure the openness and integrity demanded for these important deliberations, with their enormous impact on public costs and basic energy and environmental policy.

Scientists Speak Out

As a result of this concern, a few knowledgeable individuals and groups began to speak out.

• In 1995, Zbigniew Jaworowski, former chairman of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), published the following statement in *Nukleonika,* the International Journal of Nuclear Research.[2]

"In March 1994, UNSCEAR decided to publish its report on radiation hormesis, a phenomenon of beneficial effects of radiation. The report, 'Adaptive Responses to Radiation in Cells and Organisms,' approved after 12 years of deliberation, dispels the common notion that even the smallest dose of radiation is harmful. Myths are hard to banish, and until recently hormesis was a scientific taboo. This was because it contradicts an assumption which is a basis for the current philosophy and policy of radiation protection. Over the years, this assumption came to be regarded as a scientifically documented fact by mass media, public opinion and even many scientists."

• The French Academy of Sciences published a report in fall 1995, objecting to a proposal by the International Commission on Radiological Protection (ICRP) to lower permissible radiation limits still further.[3] The chief editor of the report stated:

"After examination of recent scientific and epidemiological data, the Academy has confirmed the opinion it gave in 1989, that there is no scientific reason to justify lowering the standards in force today, provided they are accompanied by a lifetime cumulative dose limit for occupational exposure of one sievert [100 rems]."

• The Health Physics Society, the technical society for U.S. radiation protection professionals, published a position statement on the subject in March 1996:[4]

"In accordance with current knowledge of radiation health risks, the Health Physics Society recommends against quantitative estimation of health risk below an individual dose of 5 rem in one year, or a lifetime dose of 10 rem in addition to background radiation. Risk estimation in this dose range should be strictly qualitative, accentuating a range of hypothetical health outcomes with an emphasis on the likely possibility of zero adverse health effects. The current philosophy of radiation protection is based on the assumption that any radiation dose, no matter how small, may result in human health effects, such as cancer and hereditary genetic damage. There is substantial and convincing scientific evidence for health risks at high dose. Below 10 rem (which includes occupational and environmental exposures) risks of health effects are either too small to be observed or are non-existent."

• The Advisory Committee on Nuclear Waste (ACNW) reported July 10, 1996, to its sponsor, the Nuclear Regulatory Commission (NRC):

"We conclude that a re-examination of the regulatory model is appropriate. The first task is an impartial review of the data and their quality.

"The increasing emphasis placed by the NRC on risk-informed regulation makes it imperative that the actual health risk of low levels of ionizing radiation be assessed accurately. . . . We recommend that the need for special attention be conveyed to the NCRP regarding its study. Such attention should include: (1) Assurance that the study includes scientists other than those who are 'recognized experts' with a reputation built on the LNT model; (2) An evaluation of the data by an entity with an expertise in statistics or information science but no prior position on LNT. . . . (3) Consideration of essentially all studies that could relate to the LNT.

"We will follow the [NCRP] program and will report to the Commission on the study and its implication."

These words reflect the advisory committee's concern that the secret and inadequate review process used by the NCRP in the past will not be sufficient. We share the Committee's concern and concur in its recommendations. We urge that government and private interests implement mechanisms to help assure the scientific integrity of this important process.

Radiation, Science, & Health

As part of this move to change the LNT model, in 1996, an international group of independent experts on radiation, including noted figures such as Nobel Laureate Rosalyn Yalow, formed Radiation, Science, & Health, Inc. (RSH), a not-for-profit organization. One of us had organized several technical sessions on low-level radiation at meetings of the American Nuclear Society and the American Society of Mechanical Engineers, with dozens of researchers from around the world. These sessions collected voluminous data that contradict the LNT model.

RSH has reviewed the existing materials and, on the basis of the evidence, we make the following proposals:

The first step to understand the situation is to support a modest, independent effort to review the relevant existing data, including specifically those sources that are said to support the LNT model. The raw data should be examined anew to assure that scientifically valid conclusions are drawn. Data should not be force-fit to predetermined models.

Substantial evidence of health benefits from low-level radiation should not be dismissed as "anomalous." Experiments on small organisms shielded from background radiation show deleterious effects. Proposed confirmatory experiments on small mammals have not been funded. This type of work has been suppressed and should be reviewed and evaluated. One special case is the termination of the Center for Human Radiobiology, following results that dramatically contradicted the LNT. Where such important research has been terminated prematurely, some additional research should be supported. The amount of money required for these steps could be taken from contracts now allocated to "research" whose sole purpose seems to be to further promulgate current policy and public fear—including, especially, the EPA's radon program.

This scientific review should be undertaken independently of the National Research Council and the NCRP. It should include radiation and non-radiation specialists who do not have a conflict of interest. All persons funded by government agencies and private interests that support and profit from the hundreds of billions of dollars of public resources expended for government programs, and from regulations based on the LNT model, should be considered as having a conflict of interest.

A preliminary independent inquiry on the standards-setting process itself should be undertaken. This review should not include members of the current standards-setting bodies and committees that have been involved in setting and defending the LNT model, although those persons should be invited to contribute to, and respond to inquiries, as to the basis for considering and rejecting scientific evidence.

This inquiry should address primarily the funding and defunding of persons and programs, interlocking personnel, and the controls imposed by the agencies and the standards-setting bodies and their contractors. It should address the specific areas of research, and studies that have been suppressed and/or termi-

AVERAGE ANNUAL DOSE WORLDWIDE FROM NATURAL BACKGROUND RADIATION

Source	Dose (mSv)	Percent (%)
Radon	1.3	55
Terrestrial gamma rays	0.46	19
Cosmic rays	0.39	16
Human body	0.23	10
TOTAL	2.38	

Source: UNSCEAR 1993

nated, or results left unpublished, and the researchers who have been constrained in pursuing valid areas of research—recognizing that not all decisions to fail to pursue areas of research are necessarily unjustified.

The inquiry should also address areas of research in which massive funds are expended for research of little or no scientific value, and those whose main purpose seems to be to contribute to public fears. The investigation should explore the extent to which those fears are used as a basis for Congressional funding of major projects that have no potential public health and safety benefit. It should address the response (or lack of response) by government agencies to evidence that is contrary to the LNT model (for example, the data that demonstrate that lung cancer is highest in the low-radon areas of the United States), and their efforts to suppress this information, and even produce disinformation, rather than undertake a valid scientific review of it.

This inquiry should produce a preliminary report to the Administration, to the National Academy of Sciences/National Research Council, and to the science and government affairs committees of Congress.

Undoing the Constraints

Effort will be required to re-establish an environment where researchers will feel free to work, uninhibited by political and institutional restraints as to what results are "acceptable." Right now, dozens of our best researchers are substantially proscribed from undertaking important research on the health effects of low-level radiation.

One of the most common statements of the research community in discussing knowledge and interest in this important subject is, "I could lose my funding," or "my job." This is not a standard of scientific inquiry that America should accept.

Such research includes following up on substantial work in Japan on using low-dose radiation for successfully treating cancer, and research on the millions of persons in the world who enjoy improved health as a result of living in areas of higher-than-average background radiation, or who use natural radon or radium health spas. Confirmation of this evidence, and of the seemingly beneficial effects of radon in houses, would help establish accurate dose-response relationships.

In addition, the contribution of large sources of radioactivity to the enormous biological populations surrounding deep-sea hydrothermal vents, should be studied, to establish whether radiation is the source of energy that maintains these populations 8,000 feet below sunlight.

Our major institutions should respond to the fact that no health risk is found from continuous exposure to radiation levels up to 10 times the average natural background. This should then lead to the establishment of:

- A program to assess the application of this evidence on low-level radiation to nuclear technologies. Specifically, the task is to document the cost savings that would result from changes in engineering codes and standards, design criteria, and operations, with associated large public cost savings in medicine, energy, industry, in disposing of wastes, and in environmental "cleanup" and decommissioning.
- A program to inform government, educators, media, and the public about the health effects of radiation, and to apply this information to their respective areas of responsibility and interest.
- A program to assess the role that nuclear technologies should play in solving pressing national problems, such as health and medical applications, including food and water safety and supplies, climate change, air pollution, and so on.

Conclusions

We have been uncharacteristically blunt, because it is imperative that we make clear that very important energy and environmental policies are based on premises that are scientifically invalid. Existing processes and organizations for evaluating this situation have become distorted in an effort to defend a predetermined conclusion. The implications of this situation are wide-ranging and profound.

We believe that all existing policies based on predicting detrimental health effects and fatalities caused by low-level radiation should be considered invalid, and should be required to be revised.

Actions should be taken to assess the significance of R&D to the advantages and limitations of applying nuclear technologies to important health and environmental problems.

The imperative of providing adequate electrical energy to meet projected world needs and avoid conflict over energy resources and environmental degradation over the next two or three generations must be considered. Nuclear energy can, and must, provide 20 to 30 percent of the total world energy needs for the more than 10 billion people in the world in 50 years, in order to provide any possibility for a growing world economy, with minimal environmental costs. In addition, there must be an accelerated use of nuclear technologies in supplying food and water, and medical and other resources.

Particular notice should be taken of China's extraordinary economic growth and energy needs during this period, as it does not fail to implement the economic, energy, and infrastructure development that is in the best interests of its people, along with the large current and projected growth of other Asian and developing countries.

The United States should take its appropriate leadership role in implementing the technologies and the policies that can meet the needs of a growing and sustainable world economy.

Notes

1. BEIR V, 1990. "Health Effects of Exposure to Low Levels of Ionizing Radiation, Report of the Advisory Committee on the Biological Effects of Ionizing Radiations" (BEIR Committee), (Washington, D.C.: National Academy of Sciences-National Research Council).
2. Zbigniew Jaworowski, 1994. "Hormesis: The Beneficial Effects of Radiation," *Nukleonika*, Vol. 40, pp. 3-12. A version of this article also appeared in *21st Century*, Fall 1994, pp. 22-27.
3. Academie des Sciences, 1995. "Problèmes lies aux effects des faibles doses des radiations ionisants," Rapport No. 34 (Paris), (October).
4. K.L. Mossman et al., 1996. "Radiation Risk in Perspective." Health Physics Society Position Paper, *Health Physics Newsletter* (March).

RADIATION RESEARCH

How the Data Were Suppressed and Misrepresented

by Jim Muckerheide

Starting in the World War II period, radiation research on health effects was conducted on the premise of establishing radiation protection standards. Bias was soon introduced, however, because funding was dependent on the need to establish such standards, and the results of mammal experiments did not demonstrate adverse effects at doses below tens of rem.

In 1950, researcher Egon Lorenz at the National Cancer Institute reported on ongoing work: ". . . [A]n exhaustive study was begun at the National Cancer Institute early in 1941, greatly expanded during World War II, and is still continuing. . . . The experimental animals were mice, guinea pigs, and rabbits.

"[D]ose levels were 8.8 r, 4.4 r, 2.2 r, 1.1 r, and 0.11 r, given in eight hours per day. . . . With such small daily doses, animals will stay in good health for considerable time and quite large doses can be accumulated before death occurs," Lorenz wrote.

"The conclusion may be drawn that chronic irradiation of these mice after they have reached maturity does not alter to a great extent the overall incidence [of tumors] but mainly the time at which the tumors appear. This indicates a dependence upon dose rate rather than total dose."

"Recent experiments by Kaplan [1949] give considerable support to the view that a systemic effect is involved. He irradiated only the upper half or lower half of the body. . . with the same dose. . . used in whole body irradiation of other mice (1,000 r in 10 divided doses). The incidence of lymphoid tumors in the groups that received part body irradiation was found to be about 3 to 5 percent, which is spontaneous incidence. On the other hand, the group receiving the same dose over the whole body had an incidence of 60 percent."

Westinghouse Hanford

Research on radiation health effects began in the World War II period. Here, construction workers on the Manhattan Project at Hanford Nuclear Reservation in Richland, Washington, whose health was found to be better than that of non-nuclear workers.

Lorenz also reports on the 1941-1946 studies in the Manhattan Project records (Zirkle 1954): "Mice. . . were irradiated with 4.4, 1.1, 0.11, and 0.044 r per 24-hour day. . . . Male mice conceived and living continuously under exposure to 4.4 r/24-hour day up to total doses of over 2,000 r are comparable with non-irradiated mice as far as weight, coat, and activity are concerned. . . ."

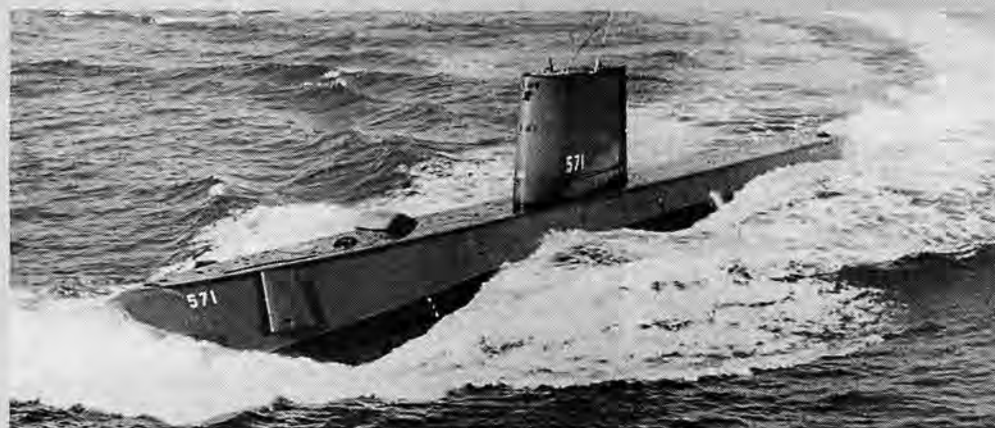
Lorenz summarizes the data plainly: "Subsequent generations reared and living under exposure of 1.1 and 0.11 r per 24-hr day show no damage to chromosomes as evidenced by the raising of 5 to 6 generations with normal litter size and an apparently normal life span."

Data Reinterpreted

In studies later in the 1950s, Lorenz's data with mice, guinea pigs and rabbits, at 0.11 r/8-hr/day demonstrated longer lives and other beneficial effects. By then, these data were misrepresented as "anomalous," although they were statistically significant and were repeated in multiple experiments.

At the same time, papers in the literature began to consistently state an unfounded and contradicted presumption that ionizing radiation "must be harmful." Research was funded to establish hazards at low doses. Researchers who reported other results were at risk, and researchers who wanted to pursue anomalous results were discouraged. Over the decades, many of these researchers have stated that the peer review process required them to make statements that were inconsistent with their results, although they were confident that their data would be recognized. As a result, the abstract and conclusions of these studies are inconsistent with the reported data.

Other research and study results were simply suppressed. From the 1950s to the 1980s, research on these "anomalies" was not supported. Senior management at the Atomic Energy Commission/Department of Energy, Oak Ridge, and other labs and universities have noted such actions.



AEC

Nuclear shipyard workers were healthier than their non-nuclear counterparts in the shipyards, according to a comprehensive, 10-year study carried out by the DOE and Johns Hopkins University, completed in 1987 at a cost of $10 million. Yet, the Nuclear Shipyard Workers Study was suppressed. Here the nuclear submarine USS Nautilus.

Nuclear Shipyard Data Suppressed

The comprehensive Nuclear Shipyard Workers Study (NSWS), completed by the DOE and Johns Hopkins University in 1987, after 10 years and $10 million of study, with the most carefully constructed matching populations of nuclear and non-nuclear workers, was simply not published. This study of 100,000 non-radiation workers and 30,000 radiation workers had the most accurate, extensive dosimetry and records. Yet, not only were the results not published, but the BEIR V report in 1990 suppressed the study, even though the chairman of the study's Technical Advisory Panel and the chairman of BEIR V were the same person!

In addition, a study of "all" U.S., United Kingdom, and Canadian nuclear workers, conducted by the International Association for Research on Cancer (IARC), did not include this definitive study of U.S. workers. Instead, it used only the much poorer nuclear weapons plant data. These data have substantial bias and confounding factors. Although this IARC study has been proclaimed as the "best evidence of the linear dose-response to low doses," its sole "evidence" is in one cancer, chronic lymphocytic leukemia, and it has only one data point for doses at greater than 40 rem, which shows 6 observed cases vs. 2.3 expected cases.

In the 113 deaths from this cancer in the data base below 40 rem, there is no increase in cancer. Based on this one data point, however, the IARC analysis discounts all data points that are lower than expected, in order to produce a "trend analysis." This trend analysis is then made to seem statistically valid by applying Monte Carlo methods, in which the 6/2.3 data point causes a positive slope.

Certainly, even if this linear trend in one type of cancer were true, and not a manipulated result, it would be potentially anomalous, contradicted by the data for the many other cancers, and for "all cancers." And even if one cancer were increased by significant radiation exposure, while all cancers were unaffected, or reduced, it would not warrant consideration as a risk—outside the vested interest in creating public fear and funding.

Calvert Cliffs and More Suppression

In 1971, the U.S. Court of Appeals decision on the Calvert Cliffs nuclear plant in Maryland, found that Atomic Energy Commission Environmental Impact Statements were inadequate under the National Environmental Protection Act for nuclear plant licensing. In response, the Atomic Energy Commission instituted the Argonne Radiological Impact Program, and charged it with providing a better basis for low level radiation effects.

As a preliminary study, Dr. Norman Frigerio, with Dr. Keith Eckerman and R.S. Stowe, analyzed cancer rates by state and average whole body doses. This study tested, and contradicted, the models of the linear no-threshold hypothesis, although it was limited in applying only the preliminary, coarse data available. There was 15 percent less cancer in high-background-radiation areas. (This result has been consistently repeated since that study.)

There were no substantive scientifically critical comments on the merit of the Frigerio analysis. In fact, equivalent methodology, with much less technical rigor, is the basis for many public health studies and public policy decisions, including recent studies that claim to find health effects from particulate emissions.

Nevertheless, in 1973, the Atomic Energy Commission and radiation science policy interests terminated the study, and its results were not published. At an International Atomic Energy Agency Conference in 1976 on natural radioactivity, a version of these study results was included in the conference proceedings. However, these results were intentionally ignored in UNSCEAR 1977, as reported by Swedish radiation scientist and UNSCEAR member, Dr. Gunnar Walinder. The results were also arbitrarily dismissed in BEIR III, although there was no substantive scientific criticism of the results to warrant such dismissal.

Radon and Lung Cancer

In the mid-1980s, Dr. Bernard Cohen, a well-known nuclear scientist at the University of Pittsburgh, personally undertook a version of this study. He tested the LNT hypothesis from the more significant data for lung cancer versus residential radon doses. (These data are stronger, because lung cancer is a more significant cancer, and radon produces higher doses and varies more widely by geographic region.) EPA also initiated such studies of background radon data. From more than 300,000 residential radon measurements, including all EPA and state data, the linear no-threshold hypothesis is contradicted. The high-radon areas of the United States have very much lower lung cancer rates than low-radon areas.

Despite the data, the non-scientific conclusion is propounded that the results should be ignored, "because it is an ecological study." Ecological studies are weak in their ability to establish a dose-response model. However, Dr. Cohen has assessed all of the identified "weaknesses" and found that they do not affect the results. In addition, these weaknesses do not apply to the LNT model. Thus, with no scientific criticism, EPA ignored these data, and then produced yet another mathematical projection from the poor data concerning uranium miners and undertook a multi-million-dollar-equivalent public relations campaign to mislead the public about radon risks.

More Misrepresentation

In 1974, researcher Robley Evans rigorously demonstrated that BEIR 1972 had substantially misrepresented the data on radium health effects, in order to produce a linear no-threshold result from extremely nonlinear data. On his 1970 retirement from MIT, the Center for Human Radiobiology was established at Argonne National Laboratory.

In 1981, an international conference reported that in the thousands of cases worldwide, there were still no cases of bone cancer or nasal carcinoma from ingestion of less than 250 microcuries (millionths of a curie) of radium-226, producing an estimated dose of 1,000 rad to the bone. The report was published in 1983. That same year, the DOE initiated program termination. EPA sets drinking water standards at 5 picocuries (millionths of a millionth of a curie) per liter.

In the 1990s, after a follow-up of causes of death in radium workers for another 10-year period, the 1983 results were further confirmed. In 1991, the Scientific Advisory Board of the Environmental Protection Agency stated that radium health effects should be based on the extensive evidence of the radium-ingestion populations. EPA responded that they had a "policy" that responses would be linear, and that to apply these data would require that the agency change its policy, which it would not consider. Apparently, science is irrelevant in establishing regulations to "protect" public health.

The data for Japanese survivors who received low radiation doses—and who are living longer than those who received no radiation doses—is also being substantially misrepresented. When the Department of Energy closed the Center for Human Radiobiology at Argonne National Laboratory, the message was not lost on the Radiation Effects Research Foundation (RERF). However, recently the DOE also tried to reassign the project from the National Academy of Sciences to a favored program at Columbia University.

The evidence that Japanese survivors are living longer than non-exposed persons is ignored, along with the fact that cancer is lower than normal in the low-dose population. All this ignores the fact of the poor low-dose data in the Japanese population. This group was exposed to an atomic bomb in war-time conditions. The low-dose group has especially poor dose estimates that are known to be underestimated, and do not include fallout doses. There are questionable analyses of data that are not made available to others, even to the BEIR analysts.

The suppression of substantial evidence from the published literature of the beneficial effects of low-level radiation, the prevention of publication of research on the topic, and the defunding of applicable research, are costing the U.S. population both money and lives. The voluminous evidence in the literature has been reported by Prof. Emeritus Don Luckey in his two books on radiation hormesis which have, respectively, 1,269 and 1,018 references.

It's time for a policy change.

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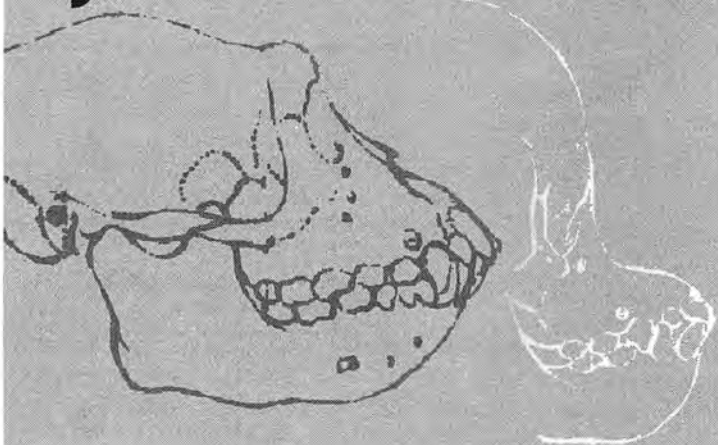
Was Darwin an Evolutionist or, Just a Social Reformer?



by Dino de Paoli

The continuing evolution of man depends on the cultivation of his inborn light—creative cognition—not Darwin's Malthusian "survival of the fittest."

Introduction

Pope John Paul II recently reaffirmed the acceptance of a theory of evolution, one which would be coherent with the fundamental Christian credo of "man created in the image of God." "With man we find ourselves faced with a difference of ontological order . . . an ontological discontinuity," he said.[1]

In the popular mind, the concept of evolution is wrongly associated only with Charles Darwin. For this reason, I will try to show that Darwin was not a real evolutionist, but, despite the pathetic attempt by his followers to hide it, merely the co-father of Social Darwinism. Today, people seem to have forgotten that Nazism was a brutal, but logical consequence of Social Darwinism; so, especially after the 1970s, they are once again willing to accept policies based on so-called "scientific" proofs, that there are too many people and too much technology.

This left-wing eco-Malthusianism has been radically escalated, since 1990, as the brutal, speculative monetarism for which man is just a commodity whose cost must be minimized. We hear, again, experts "proving" that poverty and intelligence are based on biological factors. We hear, that if entire countries are destroyed by speculators, if famine kills millions, that this is all part of natural law, part of progress achieved through the survival of the fittest. Radical monetarism and Social Darwinism are and were the two faces of the same coin: Darwin gave the supposedly scientific justification for Adam Smith and Thomas Malthus.

It is necessary, therefore, to go a step further, to expose the underlying "scientific" assumptions on which Darwinism is based.

This brings us directly to the "nature of man." It forces us to give to the "ontological difference of man" a specific meaning. For this, we have made use of the theory of "evolution" of Leibniz, and of Lyndon LaRouche.[2]

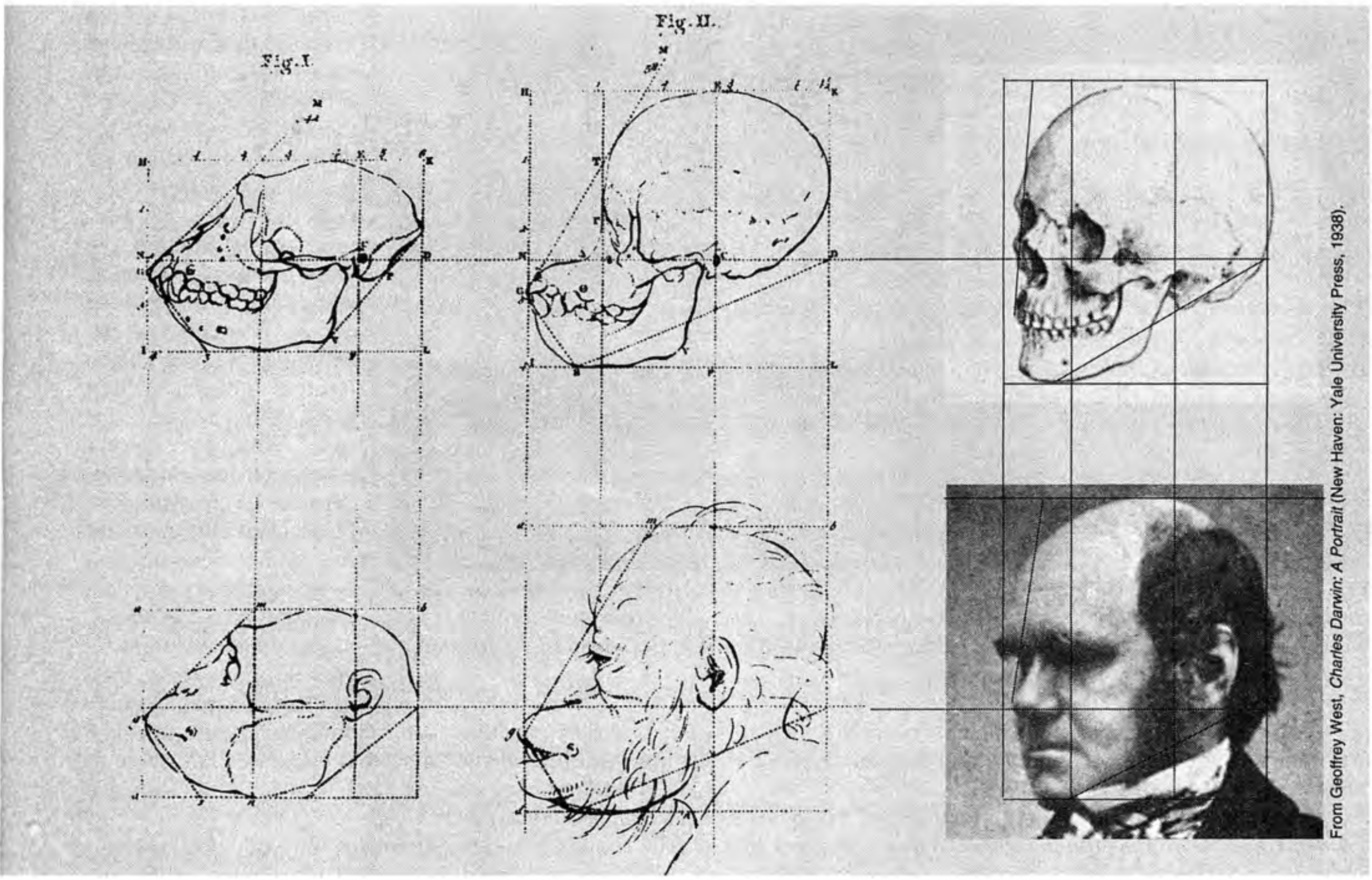
LaRouche has indicated in his presentations, and in his writings, that Leibniz's "analysis situs," seen from the standpoint of his Monadology, could make an important contribution to making intelligible the creative effect of the human mind on the world: that mind, which otherwise tends to be relegated to the ranks of the ghosts, on the presumption of the impossibility of it being determinable by mathematical or logical means. Today, as yesterday, for many, whatever cannot be measured mathematically, does not exist.

I use a story to show how a mathematical ideology could paralyze cognition. Keep in mind that Leibniz proved the "existence" of physical curves like the catenary, which Descartes had excluded, on the ground that they are not measurable by Descartes's mathematics:

Descartes, chased by a lion, arrived at a bridge. There, he might have escaped by crossing; but, he stopped. The lion arrives, and kills him. In Paradise, Saint Peter asks Descartes: "Why did you stop? Why did you not go over the bridge, and save yourself? Descartes replies: "But, but . . . Didn't you see? It was a *suspension bridge!*"

"And so . . .?"

"Do you not know?! *I* have proved *mathematically* that such catenary bridges *do not exist!*"



Darwin was the father of Social Darwinism, which spawned and nourished both racism and hatred of man in general.

Part 1. Darwin: The Zero-growth Model of Evolution

Newtonian Materialism

Charles Darwin (1809-1882) contributed to the study of evolution through the concept of *natural selection,* which, as we will see, can be applied only when the condition of *overpopulation* exists, but not under other circumstances.

For example, if five individuals are born and all can survive, there is no selection, and, according to Darwin, no direction for evolution. If ten are born, and only five can survive, then the "selection of the best" is assumed to play a role. The echo of Malthus's theory is obvious, and Darwin explicitly references him; but, researchers have confirmed that there were other important sources for Darwin: Adam Smith, (Lambert Adolphe) Jacques Quetelet, Auguste Comte, and so on.[3] If the mother of the concept of overpopulation, is Malthus, the unacknowledged father comes from a scientific ideology: materialism, in its dual form of Isaac Newton's mechanics and Georges Buffon's vitalism. These latter two shaped Darwin's doctrine, and still dominate the work of modern Darwinists.

Darwin wrote, in an early manuscript: "To avoid stating how far I believe in materialism, say only that emotions, instincts, degrees of talent, which are hereditary, are so because the brain of the child reflects that of the parent stock."[4] The opposition to materialism is not to be sought in religious fundamentalism. Darwin was also a daily reader of the Bible; but, that seems not to have helped him in grasping the nature of human beings. Moreover, it was the artificial debates with English fundamentalists, organized by Thomas Huxley, which made Darwinism popular. In that period, the real anti-materialism came from Leibniz, as expressed in his opposition to the natural philosophy of Newton, to the atomism of Gassendi, to the algebraic mathematics of Descartes, to the social and economic theory of Locke, and so forth. Even if the superiority of Leibniz's conception resulted in many of the inventions enjoyed by the elite, nevertheless, that elite's need for *Malthusian social*

Editor's note: All emphasis within quotations, indicated by italics, is the author's, unless otherwise noted.

1. Address of John Paul II to the Pontifical Academy of Sciences, Oct. 22, 1996, subsequently published in *Osservatore Romano.*
2. Lyndon LaRouche's personal contribution on this issue—through development of the concepts of *potential relative population-density* and the *anti-entropic principle of cognition* by means of which man is able to increase global "carrying capacity"—is used in the last section of this article. His works should be read directly. Among those relevant here are *The Science of Christian Economy And Other Prison Writings* (Washington, D.C.: Schiller Institute, 1991), and, "The Essential Role of 'Time-Reversal' in Mathematical Economics," *Executive Intelligence Review*, Oct. 11, 1996. The latter also appeared in *Fidelio,* Winter 1996.
3. L.A. Jacques Quetelet introduced the statistical conception of "average state," "average man," and so forth, which also inspired James Clerk Maxwell.

The Granger Collection

Crossing the impossible (for Descartes) catenary bridge, is an everyday occurrence for many commuters. Here, the George Washington bridge over the Hudson River, connecting Manhattan to Fort Lee, N.J.

policies meant that materialism had the only claim to scientific method the elite would accept, rejecting everything else as "mysticism."

This is not the place to laugh about how absurd it is to take the alchemist Newton as *the paradigm* of a scientist, nor to prove how willful was the attempt of the Marquis de Laplace to slander the crucial contributions to science of Leonardo da Vinci, Johannes Kepler, Gérard Desargues, Blaise Pascal, Leibniz, Gaspard Monge, and others. Nor should I elaborate here the role which the so-called "X Club" played, in launching Darwinism as an ideology. This club was the 19th century association that linked Thomas Huxley, Herbert Spencer, and John Tyndall to other *natural philosophers* such as Peter Tait, Lord Kelvin, James Clerk Maxwell, Hermann Helmholtz, and Abbot Moigno: all convinced Malthusians.

The role of Thomas Malthus's influence on Darwin, is usually acknowledged and accepted; but Malthus was not the "big bang" of Social Darwinism. We have to go one step lower, to see the main assumptions already present in Newtonianism, which, as Newton himself said, stood "on the shoulders of giants," such as Galileo and Descartes.

Newtonianism divided the world into two systems: a physical and a living one; the first a totality, the second, a part of it.

The first of these two, is viewed as the domain of *necessity,* or, closed mechanical systems. We select only a few of Newton's postulates of necessity, as these are relevant to Darwinism:

(a) *Objectivity:* An investigation is considered scientific, only if we can *isolate* a system from its observer, and reduce it to a set of mathematically consistent relations among its inert parts. Thus, that which was the valid practice of engineers, became after Newton, *the method.* The isolated system became *the universe.*

(b) *Completeness:* Matter is described as motion, and Euclidean mathematics is considered *complete.* Nothing can be added or taken away from it, and so, it is also eternal. Let us designate the conservation of such a given inert, fixed state, by *K.* Let us imagine *K* as the fixed quantity of water-molecules in a river.

(c) *Internal-External:* The value of the magnitude *K,* is indifferent to the linear or non-linear changes (motions) among its parts. Such internal motions, which leave *K* unchanged, are called "relative." So, either *K* is fixed for eternity, or the cause of its change has to come from outside itself. Any change of *K* itself, can be defined as *absolute, ontological,* or *discontinuous.*

Should this system be called the *universe,* then its change can come only from a *deus ex machina,* God rearranging a house in which He does not live. If such a system expresses nature completely, then human nature is also so described. Thus, we have obtained *homo mechanicus.*

Leibniz had warned that an intelligible world need not necessarily be a dead world! One could account for the efficient existence of human free will and real evolution, but one did not have to accept a mathematical determination of physical changes as an absolute determination. Such a universe, determined by a single mathematics, is not of as much significance for what it describes, as that which (it must not be permitted to hide that) it *omits.*

The Second System: Freedom, or Vitalistic Systems

And Life? Society? Mind? Do we need an extra force to explain their origin and functioning? The mechanists answer, that, one day, they will prove that our existence is a statistical accident, a deviation from the average state of matter.

We must respond with this warning from the beautiful mind of Louis Pasteur, who, after eliminating vitalism and spontaneous generation, wrote:

> You put matter before life, and you make matter eternal. How do you know that the progress of science will not force you to affirm that *life is eternal* and not matter? You go from *matter to life,* because your present knowledge tells you that you cannot understand things in a different way. Who can assure me that in 10,000 years we won't say that it is only possible to go from *life to matter?"* [5]

Mechanism, to account for the specificity of life, has to invent an extra, ad hoc model. A living cell, a society, is considered an open sub-system of the Newtonian physical universe. "Open," means that it can exchange energy with the "external," that is, the rest of the universe. To conserve itself, to live, such a cell must do external work, which consists of selecting and collecting a useful portion of energy out of the world. It does not really produce, but simply collects and consumes the fruits (free energy) of the world within which it maintains itself and grows. We call this activity *simple work.*

This mechanistic model of cell or society, as a simple part of the material universe, cannot change the value of *K,* cannot increase the amount of water from which it drinks, or the *fertility* of the world from which it collects useful energy, and so on. In this sense, the maximum number of its population is already pre-defined. Whatever (present and future) qualitative change has been allowed in its characteristics, such a change is outside of its control: it can happen only as accidental mutations. Life is not allowed really any efficient causality in the physical universe, and, thus, it is described as a parasite of matter, animals as parasites of vegetables, and man the biggest parasite of all.

In this sense, man and animal and vegetable are *equal:* all are impotent to change the physical nature in which they live. We have obtained *homo animalius.* But Leibniz's question is still there: If the universe is dead, whence came this unwanted child? The modern Newtonians answer, that the father is still *unknown,* the mother is the goddess *Chance,* and the act of procreation was an *accident.*

But let us remain within our era, and follow how, from such a Newtonian "cell," the concept of economy was derived.

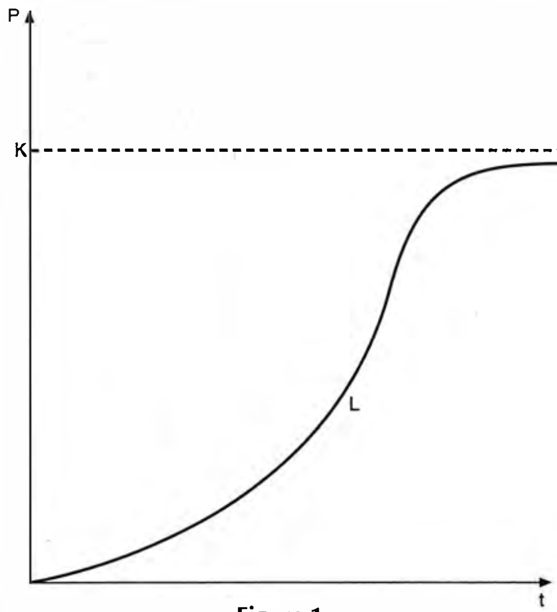


Figure 1
CARRYING CAPACITY ACCORDING TO MALTHUS
This typical "S"-shaped curve, L, is used to represent population growth, according to Malthus's theory. It indicates any growth with a limiting factor intervening to stop it. P.F. Verhulst (1804-1849) put the concept into a mathematical equation: $P_{(n+1)} = gP_n(1 - P_n/K)$, *where* P_n *is the potential at time n,* $P_{(n+1)}$ *is the number of people, or potential at time (n + 1); g is the growth factor (births/deaths); K is the carrying capacity, or limiting mechanism, such as energy, physical size of the population, natural catastrophes, and so on.*

The Economy of Simple Work

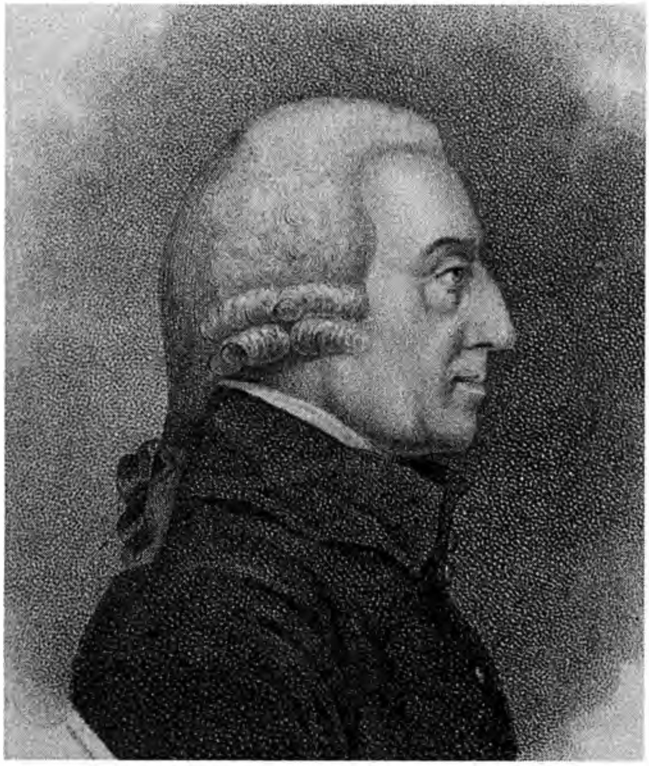
We want to show, in a simple form, how the economic theories of Smith, Ricardo, Malthus, and Marx (all related to Darwin), are based on the above concept of *simple work.* This kind of activity can accumulate relative surpluses, but cannot produce any absolute increase. The introduction of tools or machines, does not change the basic relation, except insofar as it increases the efficiency (decreases the work-time per unit of collected energy) or increases the range of activities. In this way, the local potential of the society to do work, can increase, and with it the density of local population. But, this process is comparable to one who digs holes to build a hill out of the same sand. Human societies, as also life, are conceived as parasites drinking out of a fixed flow of water, which then defines the maximum number of people able to drink. Once one approaches the vicinity of the maximum, any further increase can take only the form of a relative redistribution at the expense of others.

This is schematically illustrated in Figure 1: The curve, *L,* indicates the growth of the potential of a Newtonian physical economy through the number of people allowed (*carrying capacity*). The curve moves toward a limit, *K,* which expresses the point of zero growth or of a stationary state.

The concept of the Newtonian social economy focusses on the distribution of such relative potentials inside a society, eventually expressed in its monetary form. Given the above premises, the social becomes more and more disconnected from that physical which is thought to be unchangeable; and, so, the result becomes a simple convention, or else a struggle among powers in society to grab the most at the expense of others. We can call this last the economy of trade and property, well expressed by John Locke, who said of the individual: "The labor of his body and the work of his *hands* we may say are properly his." And, said Locke, ". . . it is labor indeed that puts the difference of value on everything. . .," and again, ". . . man, by being master of himself and proprietor of his own person and the actions or labor of it, had still in himself the great foundation of property."[6]

Adam Smith's theories are only an elaboration of this; he recognized that if work cannot create real energy, it can at least create social commodities and exchange them, such that the artificial relative profit could grow independently of nature or physical considerations. He thought that the physical regulative equilibrium of action-reaction, was paralleled by a social mechanism for equilibrium: the play between the forces of supply and demand, that is, the market. This perfect thermostat could be upset only by catastrophes, or climate changes; otherwise, through the mechanism of competition, waverings around an equilibrium line, it would define prices, salaries,

4. *Charles Darwin's Notebooks 1836-1844: Geology, Transmutation of Species, Metaphysical Enquiries,* transcribed and edited by Paul H. Barrett et al. (London: British Museum, and Ithaca, N.Y.: Cornell University Press, 1987), Notebook M, p. 532.
5. Louis Pasteur. *Pages Choisies* (Paris: Etudes Sociales, 1970), p. 56.
6. John Locke. *An Essay Concerning the True Original, Extent, and End of Civil Government,* Chapter 5, in *The English Philosophers From Bacon to Mill,* edited by Edwin A. Burtt (New York: The Modern Library, 1939), pp. 413, 419, 420.



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Darwin gave the appearance of objective science to the materialist, entropy-centered philosophy of Thomas Malthus (right) and Adam Smith (left), based on the methodology of Isaac Newton.

and so on, and especially would make sure that some part of the population does not reproduce excessively: "[P]overty, though it no doubt discourages, does not always prevent marriage." Nevertheless, Smith wrote:

> Every species of animals naturally multiplies in proportion to the means of their subsistence, and no species can ever multiply beyond it. But in civilized society it is only among the inferior ranks of people that the scantiness of subsistence can set limits to the further multiplication of the human species; and it can do so in no other way than by destroying a great part of the children which their fruitful marriages produce.[7]

In case the population shifts:

> The market would be so much under-stocked with labour in the one case, and so much over-stocked in the other, as would soon force back its price to that proper rate which the circumstances of the society required. It is in this manner that the *demand for men, like that for any other commodity, necessarily regulates the production of men;* quickens it when it goes on too slowly, and stops it when it advances too fast.[8]

To Smith, Ricardo adds: "The natural price of labor is that price which is necessary to enable the laborers . . . to subsist and to perpetuate their race, without either increase or diminution."[9]

To summarize their argument: the cyclical over- and under-stocking of commodities around a stationary state, gives the market the chance to automatically *select* the best commodity, and assure the *evolution* between successive productive cycles. Evolution in this form, can mean only relative, quantitative variations, increases in adaptive specialization, and more complex division of labor.

The social economy of Smith, operating in this way, can trigger two types of exponential growth, each with its own momentum, and fully dissociated from the level of the physical potential:

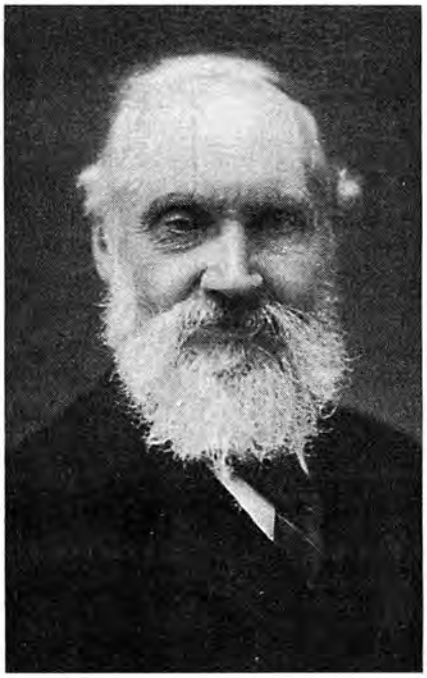
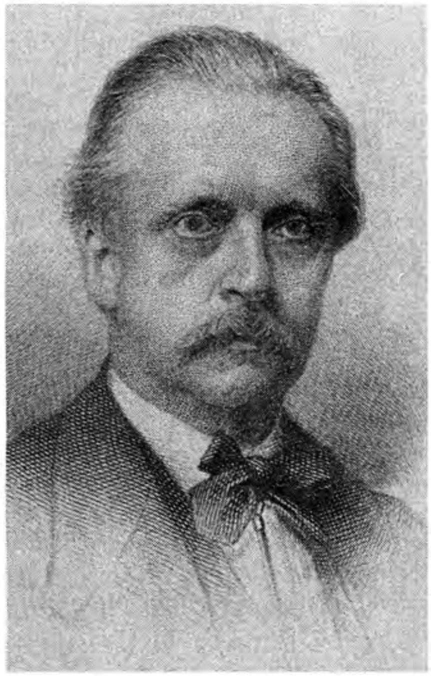
(a) The reproduction of financial capital, based upon compound interest and debts, can grow exponentially, without any relation to the limit posed by the physical constraints. This becomes more and more artificial—"hot air."

(b) The rate of reproduction of populations, can also escape the control of the supposed regulative mechanism of the market.

This second problem was elaborated by Malthus within the same Newtonian parameters. Before we consider this, we need to introduce the last physical element defining Newtonian dynamics.

The Newtonian Entropic System

Leibniz had pointed out, that, except in the virtual world of mathematics, a Newtonian world cannot really be in stable equilibrium: its dead atoms would come to a stop.[10] The planets would slow down and fall into the Sun; no new suns would form to replace the exhausted cinders of the old: no more action-reaction, nothing. After many closed recyclings, the water of the river has become inert atoms. But if

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Among the "universally entropic" scientists who promoted Darwin in the mid-19th century, were Thomas Huxley (shown here with the skull of some unfortunate), Lord Kelvin (Sir William Thomson), and Hermann Helmholtz, all members of the X-Club.

the river disappears, we can easily imagine what happens to the Newtonian system's alleged parasites: Life and man are doomed.

The circle around the X-Club, with Kelvin in 1852, and Helmholtz in 1854, brought the physical premise of the Newtonian system to its logical conclusion, by formulating the so-called "law of universal entropy." Here is Kelvin's version:

> (1) There is at present in the material world a universal tendency to the dissipation of mechanical energy. (2) Any restoration is impossible . . . (3) . . . within a finite period of time to come the earth must . . . be, unfit for the habitation of man.[11]

Amen! Life, and man, eat useful energy, and produce nothing. In this way, life is speeding up the death of the universe! This is the current conclusion of mechanism. We have been degraded from the role of parasite, to that of a cancer. Smith, Malthus, Ricardo, and company thought they had already recognized this in what they perceived as the degradation of agriculture. "Natural fertility," they thought, is not constant, but instead, runs down: crop yields decrease, productivity declines. Malthus, in his *Essay on the Principle of Population,* used Euler's calculations to prove, that in the United States (the country indicated by Smith as unique in having real economic growth):

> . . . the population when unchecked goes on doubling every 25 years, or increases in geometrical ratio . . . while the rate of increase of the natural products is not so. And when acre has been added to acre till all the fertile land is occupied, the yearly increases of food must depend on the amelioration of land in possession. This is a *stream* (or a fund) which, from the nature of all soils, instead of increasing must be gradually diminishing.[12]

Malthus's solution was a combination of social prevention of marriages for the poor, and the freedom of the market to decide the level of wages, so as to regulate the number of people without any artificial or social assistance for the poor. The German economist Friedrich List was one of the few who realized, that in a Newtonian cycle, entropy will push "carrying capacity" toward zero, no matter how much the reproduction of the poor is prevented. It is stupid, he said, to take a given productive power as an absolute measure of the potential population density.[13]

7. Adam Smith. *An Inquiry into the Nature and Causes of the Wealth of Nations,* Book 1, Chapter 8, in the Glasgow edition of the works and correspondence of Adam Smith, Vol. 1 (Oxford: Clarendon Press, 1976), pp. 96-97.
8. Adam Smith. *Wealth of Nations,* Book 1, Chapter 8, p. 98.
9. David Ricardo. *Principles of Political Economy and Taxation,* Chapter 5 (London: J. Murray, 1817), p. 90.
10. Gottfried Leibniz. Second Letter to Clarke. See "The Controversy Between Leibniz and Clarke" in *Gottfried Wilhelm Leibniz: Philosophical Papers and Letters,* edited by Leroy E. Loemker (Dordrecht: Kluwer Academic Publishers, 1989), hereinafter referred to as "Loemker," pp. 677-679.
11. William Thomson, later Lord Kelvin, 1852. *The Philosophical Magazine* (London, Edinburgh, Dublin), Fourth Series, Vol. 4, p. 304.
12. Thomas Malthus. *An Essay on the Principle of Population,* 6th edition, 1826, in *The Works of Thomas R. Malthus* (London: W. Pickering, 1986), Vol. 2, p. 10.
13. Friedrich List elaborates this in *Das Nationale System der Politischen Ökonomie* (The national system of political economy), specifically in Book 2, Chapter 11 (Basel: Kyklos Verlag, 1959), p. 140. Also, Justus Liebig, in 1840, discovered synthetic fertilizers, and thus broke the idea of the fixed organic cycle; his evidence was rejected by the Royal Society in London, which refused to publish his results.

By that standard, he added, there was already overpopulation with 1 million hunters in the Paleolithic!

Newtonian Ecology: Charles Darwin

Darwin adopted the Newtonian outlook to explain the changes in the living world. He presented this as a theory in 1859 in *On The Origin of Species by Means of Natural Selection, or,* The Preservation of Favored Races *in The Struggle for Life.*[14] The full title, with emphasis added, is used here to emphasize that Darwin has in mind the selection of "favored races," from the beginning. The process which led to the formulation of the theory, correctly here called by Darwin a *metaphor,* can be summarized as follows:

(a) It was evident, that the living world was characterized by differences and variations, whose motor Darwin could not find. Today, this is attributed to a "highly improbable, random" process of mutations. It was also evident, that there were hereditary transmissions of similarities and certain differences. But the nature of heredity, also remained a mystery to Darwin. He overlooked what, in the meantime, the Augustinian monk Gregor Mendel, a biologist, was discovering in Brunn, Bohemia.

(b) Darwin formulated his form of evolutionary hypothesis,

> that species undergo modification, and that the existing forms of life are the descendants by true generation of pre-existing forms.[15]

This was not original to Darwin, as he himself frankly admitted; the real debate was, indeed, focussed not upon the existence of evolution, but on what form it took. How a cell, or a population, grows, differentiates, reproduces itself, and specializes, and especially, what accounts for the differences between man and the animals? Those were the key questions to be answered.

Darwin says that his insights, to find the "means of modification and coadaptation" of species,[16] had to wait until 1838, when he was inspired by two things: first, "the study of domesticated animals and of cultivated plants."[17]

That is, man-made selection. To use an economic image, we could imagine the breeder as the demander, and Nature the supplier. Nature overproduces, and the breeder selects the best commodity to be re-input into the mysterious factory of Nature called life, with the result of slow, continuous progress, at least for the breeder. But, with this simple process, no breeder has ever created a new species!

The above was a necessary, but not sufficient means to obtain an automatic model for nature. Who is, here, the universal breeder? God? Mrs. Chance? Mr. X? The second and complementary illumination for Darwin came from Malthus:

> . . . I happened to read for amusement Malthus on *Population,* and being well prepared to appreciate the struggle for existence, . . . it at once struck me that under these circumstances favorable variations would tend to be preserved and unfavorable ones to be destroyed. The result of this would be the formation of new species.[18]

Nature is now, at the same time, the supplier, the demander, and the marketplace. Nature overproduces some commodity in relation to others; but, after studying Smith, Nature learns that crises can be used as a means for progress, if free *competition* is allowed in the marketplace. Nature being a totality, a monopoly, she cannot compete with anybody else! But she had the creative idea (without telling Smith) to have *animated* commodities, so that they could compete among themselves! Who wins is, by definition, the best (Nature is logical), and, as the best, it will be re-input into the life factory, and will, automatically, improve the next generation.

In Darwin's own words:

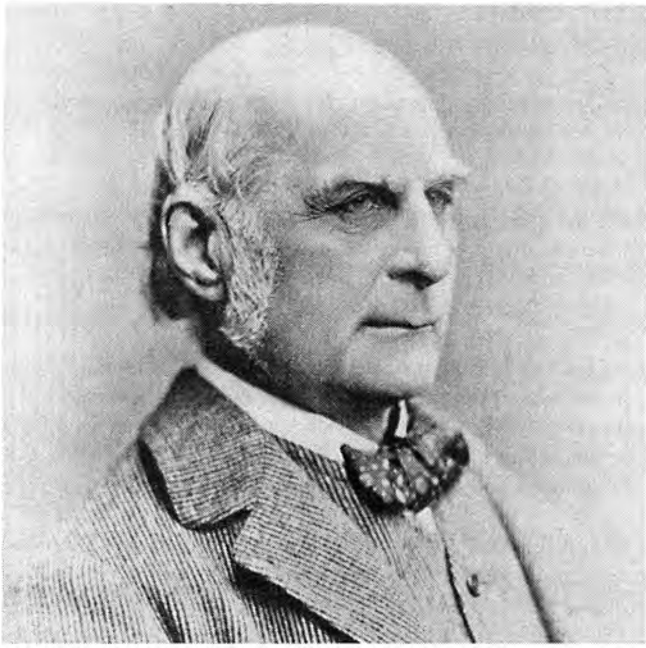
> [T]he Struggle for Existence amongst all organic beings . . . *inevitably* follows from the high, geometrical ratio of their increase . . . . As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, *if it vary* however slightly in any manner profitable to itself, . . . will have a better chance of surviving, and thus be *naturally selected.* From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form. . . . Natural Selection . . . causes much Extinction of the less improved forms of life, and leads to what I have called Divergence of Character.[19]

But, the really old problem is still there. Darwin says: "if it vary"; but how? who? what? This seems not to interest Darwin, who seems not to be interested in the factory, in the producers. After all, Darwin was just a famous, and big, landlord!

The success of the theory was immediate, not necessarily on the basis of its details, but on what was perceived as the essential point of the argument. That point was: Man is like any other animal. At one stroke, the entire Christian tradition is scuttled. But, why is this—as Darwin argues it—so? Where are the proofs? Darwin answers that, after all, we are just a variety of the same commodity produced by a Newtonian factory which *never changed* its production mode; its owner never invented anything new, never discovered any revolutionary technology! Poor Life! Were this really the case, she would be bankrupt, and already an absolute ruin!

To affirm that man is equal to an animal, is a strong declaration, given its social implications. One would expect some independent proof of it, and not *just a theorem* of a geometrical model of evolution, which, in his assumption, had already declared impossible any change of invariance. That type of factory will produce forever only potatoes, or eventually some other vegetable, but nothing else![20]

One hundred and fifty years of the most intensive researches by the Darwinians to gather proof that there is *no difference* between animal and man, has brought back only contrary proofs. The more the genetic apparatus looks similar, the more the mental differences cannot be bridged. Nevertheless the pretense is that all is done, *rien ne va plus,* we have proved everything, except some comma here and there. Very often, we hear something of this sort: "Galileo removed the Earth from the center of the universe; Darwin removed man from the kingship of creation; man is just an accident of life, which is itself an accident in the silent, indifferent material universe, itself slowly dying!" How beautiful! How objective! How "scientific"!



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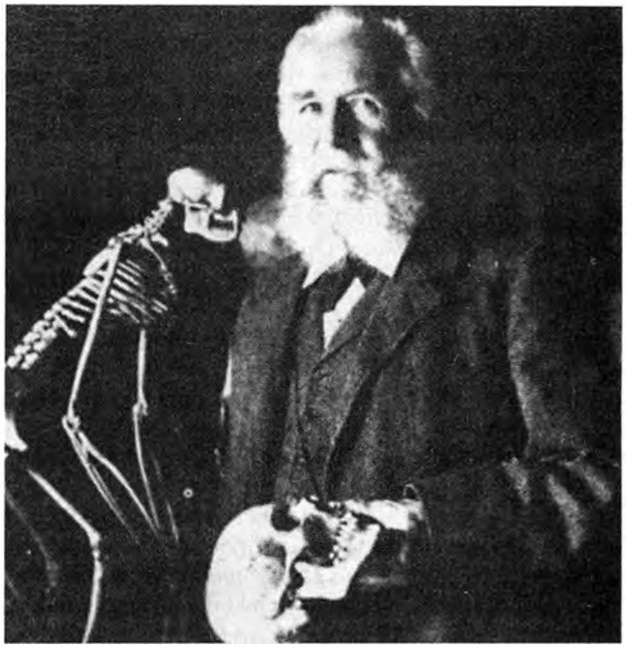

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The racist and eugenicist views of Darwin's cousin, Francis Galton (1822-1911), at left, and the German Darwinian, E.H. Haeckel (1834-1919), were amplified by Darwin in his 1871 book The Descent of Man. *All three considered mental qualities to be inherited, and human intelligence and morality as simply evolved animal instincts.*

It could be said that all this did not have to wait for Darwin! Hobbes and Locke had already said that man is but an animal. Smith had already spoken of man as a commodity. Slavery was a long-established practice. That children could be over-produced, just to be sold as a commodity to work in factories, did not have to wait for Darwin. That, in the "free-market" system in England, wages lost 50 percent of their value in 10 years, was also there before Darwin. Then, what is new? Why the need for Darwinism?

What is new, is that now, "objective science" has spoken: Nature has made a revelation to Darwin! Before Darwin, we were faced with social theories; one could always suspect some secret interest behind them. That would transform theory into ideology, and, as such, subject to political fight. But now, an ideology has become "natural law"—like Newton's laws. Auguste Comte had fully understood that; if one leaves the construction of social ideologies to philosophers and economists, then one risks revolutions. For this reason, one needs "positive, scientific" social theory, to have stable, synarchistic societies, or stable empires.

Darwin proudly stated that he, in the tradition of objective science, like Newton, needed no hypotheses. But, we have already seen his bad hypothesis. Moreover, he was no real experimenter when compared to real scientists of the same period, such as Mendel and Pasteur.

From Natural Selection to Social Selection: Social Darwinism

Inspired by Darwin, his cousin Francis Galton wrote *Hereditary Genius* in 1869,[21] in which he developed the theses, that mental qualities are biologically inherited, that the white race is biologically shaped to dominate, and that, among those of the white race, naturally the English are the best. Furthermore,

"The more a Darwin discovers a *correct* theory of some unity between men and chimpanzees, the more he has found *differences* between himself and the chimpanzees."

in England, he wrote, where there was one genius per 4,000 inhabitants, naturally, the Darwin family had the highest density of geniuses! We can easily imagine why Darwin, after reading this, wrote to Galton:

> I do not think I have ever in all my life read anything more interesting and original. . . . You have made a convert of an opponent. I congratulate you on producing what I am convinced will prove a memorable work.[22]

14. Charles Darwin. *The Origin of Species by Means of Natural Selection or the Preservation of Favored Races in the Struggle for Life* (New York: Modern Library, 1949).
15. Charles Darwin. *The Origin of Species*, Historical Sketch, p. 3.
16. Charles Darwin. *The Origin of Species*, Introduction, p. 12.
17. Charles Darwin. *The Origin of Species*, p. 12.
18. *The Autobiography of Charles Darwin and Selected Letters*, edited by Francis Darwin (New York: Dover Publications, 1958; reprint of D. Appleton edition of 1892), pp. 42-43. Similar remarks are also found in Notebook D of Darwin's *Notebooks* (see note 4 above).
19. Charles Darwin. *The Origin of Species*, Introduction, p. 13.
20. For example, D'Arcy Thompson represents evolution as a simple geometrical transformation with constant invariance, in *On Growth and Form* (Cambridge: Cambridge University Press, 1961), pp. 318-319.
21. Francis Galton. *Hereditary Genius* (London, 1869).
22. Letter to Galton, Dec. 23, 1870, in *More Letters of Charles Darwin* Vol. 2, p. 41 (New York: D. Appleton & Co., 1903).

Thereafter, Darwin made extensive use of Galton's book.

Later, Galton co-founded, with Darwin's son, the Society for Eugenics, with the aim of improving humans by selective parenthood, and "to give a better chance to the more suitable races or strains of blood." In the meantime, in Germany, E.H. Haeckel, the other Darwinist, promoted eugenics and euthanasia, all modelled on Sparta, and created the concept of "Oekologie," as a monistic totality of man-animals. All this was part of a new, natural religion to be realized, no doubt, with the help of his monist Masonic lodge, "zur aufgehenden Sonne" (To the rising Sun). Darwin himself published *The Descent of Man* in 1871.[23] Here, he drops any pretense of science; he merely amplifies Haeckel's monism, which had already affirmed that the differences between man and the chimpanzee were only simple, *quantitative* ones, and that there is more difference between a chimp and a fish, than between man and a chimp.

Darwin adds, that all the visible differences are the result only of natural selection, which promotes variation in the form of specialization, to better capture energy. From this process came what he considered the crucial human development: the development of *free hands*. But let us follow Darwin's thought directly:

> We have now seen that man is variable in body and mind; and that the variations are induced, either directly or indirectly, by the same general causes, and obey the same general laws, as with the lower animals. . . .
>
> Man . . . is the most dominant animal that has ever appeared on this earth. . . . He manifestly owes this immense superiority to his intellectual faculties, to his social habits . . . and to his corporeal structure.[24]

Darwin then develops a detailed comparison between the human mind and animal mind, as categories. Man feels, he says, but so do animals; man loves, but animals also love; man has religion, but how does one know whether animals have religion? Here, we see the typical mistake of Kantianism made even by some of the best-motivated people. Materialism can accept mind as a subjective consciousness, reduced to categories, but without any *efficient causality* with respect to physical or biological nature. The notion of reason as intelligent will, and love as participation in God's will, is never introduced. Intelligence, at best, is a simple increase in *power* of domination. And, who has more power, can obviously also define who is more intelligent. According to the same monistic logic, human intelligence, and other mental qualities and moral attitudes, are nothing but evolved animal instincts, and, as instincts, mental qualities are also biologically inherited:

> The variability or diversity of the mental faculties in men of the same race, not to mention the greater differences between the men of distinct races, is so notorious that not a word need here be said. So it is with the lower animals. . . .
>
> So in regard to mental qualities, their transmission is manifest in our dogs, horses, and other domestic animals. Besides special tastes and habits, general intelligence, courage, bad and good temper, &c., are certainly transmitted. With man we see similar facts in almost every family; and we now know, through the admirable labors of Mr. Galton, that genius . . . tends to be inherited; and, on the other hand, it is too certain that insanity and deteriorated mental powers likewise run in families.[25]

Natural selection had so far done a good job: the English were the most powerful and the most sexually active, and the Darwin family among the most intelligent (according to Galton, at least). So it was, and, through inheritance, so it should continue: "Laissez-faire laissez-aller":

> There is reason to suspect, as Malthus has remarked, that the reproductive power is actually less in barbarous, than in civilized races. . . . It is also probable that the increased fertility of civilized nations would become, as with our domestic animals, an inherited character. . . .[26]

But, just in case funny sexual practices should spread among the upper classes, then, Nature has also devised a negative way to assure social stability:

> The greater death-rate of infants in the poorest classes is also very important; as well as the greater mortality, from various diseases, of the inhabitants of crowded and miserable houses, at all ages.[27]

Should this not be enough, Nature delegates the selected best to reduce the birth rate of the loser:

> Malthus has discussed these several checks [wars, famine, and so on], but he does not lay stress enough on what is probably the most important of all, namely infanticide, especially of female infants, and the habit of procuring abortion. . . . Licentiousness may also be added to the foregoing checks. . . .[28]

The Inversion, or: 'The Crucified and Dionysos'

Nature and elite were sufficient to keep stability. But, somehow, a mistake in the process of selection of *values* must have occurred. Some external factor above and outside the process seems to have interfered. Other values not coming from instincts seem to have sneaked in from somewhere. And *dominion* feels endangered. Darwin writes, in *The Descent of Man:*

> With savages, the weak in body or mind are soon eliminated; and those that survive commonly exhibit a vigorous state of health. We civilized men, on the other hand, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed and the sick; we institute poor-laws; and our medical men exert their utmost skill to save the life of every one to the last moment. There is reason to believe that vaccination has preserved thousands, who from a weak constitution would formerly have succumbed to small-pox. Thus the weak members of civilized societies propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man. It is surprising how

soon a want of care, or care wrongly directed, leads to the degeneration of a domestic race; but excepting in the case of man himself, hardly any one is so ignorant as to allow his worst animals to breed.[29]

And, later:

A most important obstacle in civilized countries to an increase in the number of men of a superior class has been . . . that the very poor and reckless . . . almost invariably marry early. Those who marry early produce . . . many more children. . . . Thus the reckless, degraded, and often vicious members of society tend to increase at a quicker rate. . . . Or as Mr. Gregg puts the case: "the careless, squalid, unaspiring Irishman multiplies like rabbits: the frugal, foreseeing, self-respecting, ambitious Scot, stern in his morality, spiritual in his faith, . . . passes his best years in struggle and in celibacy, marries late, and leaves few behind him. Given a land originally peopled by a thousand Saxons and a thousand Celts—and in a dozen generations five-sixths of the population would be Celts, but five-sixths of the property, of the power, of the intellect, would belong to the one-sixth of Saxons that remained. In the eternal 'struggle for existence,' it would be the inferior and *less* favored race that had prevailed—and prevailed by virtue . . . of its faults" [emphasis in original].[30]

Darwinist Friedrich Nietzsche would have said, that the "priestly moral values" are killing the super-men of the super-nations. If one does not vomit in disgust, and still uses logic, it should follow from the above, that the natural "savages" will become progressively better than the English! But not so. Not so simple, not to Us: We know better! Darwin asks, could we have forgotten what Locke says about work, power, and property? He adds:

Man accumulates property and bequeaths it to his children, so that the children of the rich have an advantage over the poor in the race for success, *independently of bodily or mental superiority*. . . . But the inheritance of property by itself is very far from an evil; for without the accumulation of capital the arts could not progress; and it is chiefly through their power that the civilized races have extended, and are now everywhere extending their range, *so as to take the place of the lower races*.[31]

To Hell with logic, mind, ideas, love, and science! The real objective now comes out: let us talk reality—and before we talk, "how big is your bank account actually?" Stupid Macchiavelli, who said that Man produces money, but money produces no Man. To Hell with the so-called "Darwinian democracy"; that was for the fools. At stake is power, and only power. The "science" of natural selection shows its real face: not the survival of man and through man of the biosphere, but the survival, *at all cost,* of the oligarchy, even if their "egoistic genes" have lost a bit in potency after all their inbreeding.

Nietzsche had been more directly theological in his Darwinist insanity. According to him, the poor, the losers, all those biologically inferior people, were trying to win the competition by inventing values derived "from a concept of God invented as the antithetical concept to Life." And Nietzsche screams inversion! Inversion!

Have I been understood? . . . Dionysos against the Crucified.[32]

Nietzsche had been *well* understood, as expressed in Darwin's own final solution:

If the specified checks . . . do not prevent the reckless . . . and other inferior members of society from increasing at a quicker rate than the better class of men, the nation will retrograde, as has too often occurred. . . .[33]

Therefore,

There should be *open competition* for all men; and the most able should *not be prevented by laws or customs from succeeding best* and rearing the largest number of offspring.[34]

Let Dionysos loose without interference in the global marketplace. Let the wolves run free in the sheep pen, and let there be a democratic contest. Do not protest! Murder is now an *objective scientific law!* Mass emigrations? Tribal wars? Do not worry, all is natural, all due to the normal competition, because of overpopulation! So keep your feelings to yourself, leave morality out of economy! Let natural selection take its course. In any case, if one accepts the postulate that "man born in the image of God" is a dispensable myth, with no relation to this world, if one accepts the Newtonian postulate, then the Darwinian conclusions are correct, no matter what one's own moral impulses.

We have seen the "right-wing" conclusions of Darwin. Now, let us close the vicious circle. Let us go back to the beginning, through the "left-wing" Darwinists. Frederick Engels wrote, in his 1876 German essay, *Antheil der Arbeit an der Menschwerdung des Affen* (The Part Played by Labor in the Transition from Ape to Man):

Labor is the source of all wealth, the political economists assert. . . . But it is even infinitely more than this. It is the prime basic condition for all human

23. See the last reference in note 60, below, for the Cantor-Haeckel controversy, and for Haeckel's relation to masonry, see F. Bolle in *Medizinhistorisches Journal*, Vol. 16, p. 280 (1981).
24. Charles Darwin. *The Descent of Man and Selection in Relation to Sex*, 2nd edition (London: J. Murray, 1874), pp. 47-48. I have ordered the quotations from *The Descent of Man* that follow to bring out the content.
25. *Ibid.*, pp. 27-28.
26. *Ibid.*, p. 45.
27. *Ibid.*, pp. 44-45.
28. *Ibid.*, p. 46.
29. *Ibid.*, pp. 133-134.
30. *Ibid.*, p. 138.
31. *Ibid.*, pp. 134-135.
32. Friedrich Nietzsche. *Ecce Homo* (London: Penguin Books, 1979), pp. 133-134 (the final pages of "Why I am a Destiny").
33. Charles Darwin. *The Descent of Man*, p. 140.
34. *Ibid.*, p. 618.

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Leibniz's search for higher properties in investigating the geometry of space, led him to a series of major discoveries, including the infinitestimal calculus, and analysis situs, the calculus of situation.

> existence, and this to such an extent that, in a sense, we have to say that labor created man himself.[35]

Then, after explaining how the apes eventually developed *free hands,* Engels comments:

> This was *the decisive step in the transition from ape to man.*[36]
>
> But the decisive step was taken: *the hand had become free* and could henceforth attain ever greater dexterity and skill. . . .
>
> Thus the hand is not only the organ of labor, *it is also the product of labor.* Only by labor, by adaptation to ever new operations, . . . and by the ever renewed employment of this inherited finesse in new, more and more complicated operations, has the human hand attained the high degree of perfection that has enabled it to conjure into being the paintings of a Raphael. . . .[37]

But, concludes Engels, human beings eventually concentrated more on their heads than their hands, and so:

> All merit for the swift advance of civilization was ascribed to the mind, to the development and activity of the brain. Men became accustomed to explain their actions from their thoughts instead of from their needs . . . and so there arose in the course of time that idealistic outlook on the world which, especially since the end of the ancient world, has dominated men's minds.[38]

Engels's hatred of human creativity was, and is, the problem. How could one fail to see, that the first moment man was man, it was the conscious use of his creative mind that made the difference? From the first moment man looked at the stars, or discovered fire, or a tool, or selected seeds, he was using his cognitive powers as a physical force—not in competition against other men, but on behalf of a society living in the only possible way that coheres with a developing world. Had man culturally transmitted to the future only a technique, a tool, after a while, society would have *necessarily* fallen into the Malthusian-Darwinian logic of survival. This has now happened.

We have all seen how chimpanzees transmit the discovered use of a tool to the next generation, how the mother patiently teaches her small, stubborn offspring how to use a stick. Animals have cultures! But *only man* has learned the intrinsic limit of the protracted use of any simple discovered tool or theory over many generations. Only man has discovered that he had to learn how to willfully evolve superseding discoveries, tools or theories; that he had to change the type of his energy collecting modes. He had not only to remind the next generation of the innate power of creativity, but to educate them in its use. Only ideologies can kill civilizations, and only creativity keeps them alive.

This is what we must now turn to, the case of *homo humanus.*

Part 2. Leibniz's Analysis Situs: Where Is Continuity Located?

The Unity

Darwin wrote that his theory of simple continuous evolution was based on the motto "Natura non facit saltum" (Nature is not discontinuous).[39] For Darwin, this meant that given two creatures or objects, A and B (for example, man and chimpanzee), one can always find some homogeneous unit, a part of A or B (that is, a measuring rod), to establish differences in quantity or in forms. Leibniz had used the same motto to exemplify his principle of physical continuity, or sufficient reason. This was, in a sense, the unifying principle for most of Leibniz's discoveries in mathematics and physics. But, probably, Darwin missed the paradox behind Leibniz's own attempt to represent such a general principle as a "universal characteristic," an absolute measure to judge truths, and to measure quantitative and qualitative evolution in the world.[40]

Einstein, once, wrote of Kepler:

> Our admiration for this splendid man is accompanied by another feeling of admiration . . . of the harmony of nature into which we are born. . . . It seems that the human mind has first to construct *forms independently,* before we can find them in things. Kepler's marvelous achievement is a particularly fine example of the truth that knowledge cannot spring from experience. . . .[41]

And:

[S]cience cannot grow out of empiricism alone . . . we need to use free invention. . . . In the nineteenth century [on the other hand], many still believed that Newton's fundamental rule 'hypotheses non fingo' should underlie all healthy natural science.[42]

If this is true, then to find any type of continuity or law of nature, one has to start with human creativity; Leibniz knew what that was, while Darwin, instead, was proud to be a Newtonian. Empiricism is generally limited as a method, but it becomes even paradoxical, when, instead of planets, it takes *man* as the object of its analysis. A mathematical theory, to be predictive, has to be *homogeneous* with the empirical data, but that is impossible when man is its object.

It is important to keep in mind, in this context, that it is not only the discovery of a unity that requires free invention, but also the discovery of *differences;* and to discover differences between two creatures or objects, as, for example, man and chimpanzee, leads, necessarily, to a self-reflexive process. To forget that, would lead a person, so misguided, into thinking, that, because the study of corpses can result in a new anatomical theory, to have a universal theory one needs only to include himself as a corpse! That approach would miss something. The more a Darwin discovers a *correct* theory of some unity between men and chimpanzees, the more he has found *differences* between himself and the chimpanzees.

But, let us follow this process in Leibniz himself. Leibniz was influenced from early life by the writings of Nicholas of Cusa and his school: Leonardo da Vinci, Johannes Kepler, Blaise Pascal. The main assumption of this school, was the intelligibility, for man, of the reflexivity between the *macrocosm* and *microcosm:* The whole determines its parts; but, if the part is only that, then the whole is dead. Pascal formulated it very poetically, "By space the universe encompasses and swallows me up like a point; by thought I comprehend the world."[43]

After Pascal, Leibniz shows, that even a point is more than a homogeneous point; but, before we arrive there, we must look at Leibniz's earliest writings. In his 1666 *Dissertation on the Art of Combinations,* Leibniz wrote:

Any number of things whatever [even infinite] may be taken simultaneously and yet be treated as one whole. . . .

One infinite [whole] is greater than another. . . .

Since number [as whole] is therefore something of greatest universality, it rightly belongs to metaphysics. . . .[44]

And,

. . . the disposition [order] of the smallest parts . . . in relation to each other and to the whole can itself also be varied. Such a disposition is called *situs.* . . .

Situs is either absolute or relative; the former is that of the parts with respect to the whole, the latter that of parts to parts.[45]

Absolute changes are defined by Leibniz as qualitative. So some unity of the world is assumed, and with it harmony, coherence, intelligibility, and some form of continuity, but of which form? In 1672, Leibniz is in Paris, confronted with Descartes's mathematics. He comments, some years later, in a letter to Huygens:

. . . I am still not satisfied with algebra [the algebra of Descartes] . . . so far as geometry is concerned, we need still another analysis . . . which will express *situation* [situs] directly as algebra expresses *magnitude* directly [emphasis in the original].[46]

When he wrote this, he had already bypassed algebra with his new mathematical inventions. But more interesting for us here, is, that, to achieve this, he also had to question the validity of what was considered the most obvious expression of the harmony of the world: Euclidean geometry. Leibniz, wrote, for example, in "On Analysis Situs,"

What is commonly known as *mathematical analysis* is analysis of magnitude, not of *situation* . . . *magnitude* is in fact measured by the number of determinate parts, yet this number may vary for the same fixed thing, depending upon which measure or unit is assumed. . . .

Euclid himself was forced to assume certain obscure axioms, without proof, in order to proceed with the rest. . . .

Quantity can be grasped only when the things [to be compared] are actually present together or when some intervening thing can be applied to both . . . [or] if some third object be carried from one to the other . . . if, for instance, some measure such as a yard or a foot . . . be applied first to one and then to the other.[47]

Euclidean mathematics was the first mode for finding continuity, for finding something that stays equal during a change; something that does not change. But, the "obscure" axiom behind all this was that to transport a rigid line (measuring rod),

35. Frederick Engels. "The Part Played by Labor in the Transition from Ape to Man," in Karl Marx and Frederick Engels, *Selected Works*, 2 volumes (Moscow: Foreign Languages Publishing House, 1962), Vol. 2, p. 80.
36. *Ibid.*, p. 80.
37. *Ibid.*, p. 81.
38. *Ibid.*, p. 87.
39. Charles Darwin. *The Origin of Species*, p. 208.
40. On this account, Leibniz's conception of the "One/Many" problem, was that of Plato, as reflected in Plato's *Parmenides.* One of Leibniz's numerous recapitulations of this conception is featured in the last of Leibniz's letters to Antoine Arnauld (Loemker, note 11 above, pp. 338-350, and on p. 350, endnote 26). This is also one of the central, recurring themes within the Leibniz-Clarke Correspondence.
41. "On the Occasion of the 300th Anniversary of Kepler's Death," in Albert Einstein, *Ideas and Opinions* (New York: Crown Trade Paperbacks, 1982), p. 265.
42. Abraham Pais. *The Science and the Life of Albert Einstein* (Oxford: Clarendon Press 1982), p. 14.
43. Blaise Pascal. *Thoughts,* translated by W.F. Trotter, in The Harvard Classics, Vol. 48 (New York: P.F. Collier & Son Co., 1910), Pensée No. 348. Trotter's "an atom" has been replaced with "a point" for present purposes. The original reads:
"Par l'espace, l'univers me comprend et m'engloutit comme un point; par la pensée, je le comprends."
44. Gottfried Leibniz. "Dissertation on the Art of Combinations" (1666) in Loemker (note 10 above), pp. 73, 75, 77.
45. *Ibid.*, p. 77.
46. Gottfried Leibniz to Christian Huygens, Sept. 8, 1679, Loemker, p. 248.
47. Gottfried Leibniz. "On Analysis Situs," Loemker, pp. 254-255. For a stunning comparison, see also the opening paragraphs of Bernhard Riemann's 1854 habilitation dissertation, *Über die Hypothesen, welche der Geometrie zu Grunde liegen* (On the Hypotheses Which Underlie Geometry), *Bernhard Riemanns Gesammelte Mathematische Werke* (New York: Dover Publications reprint, 1953).

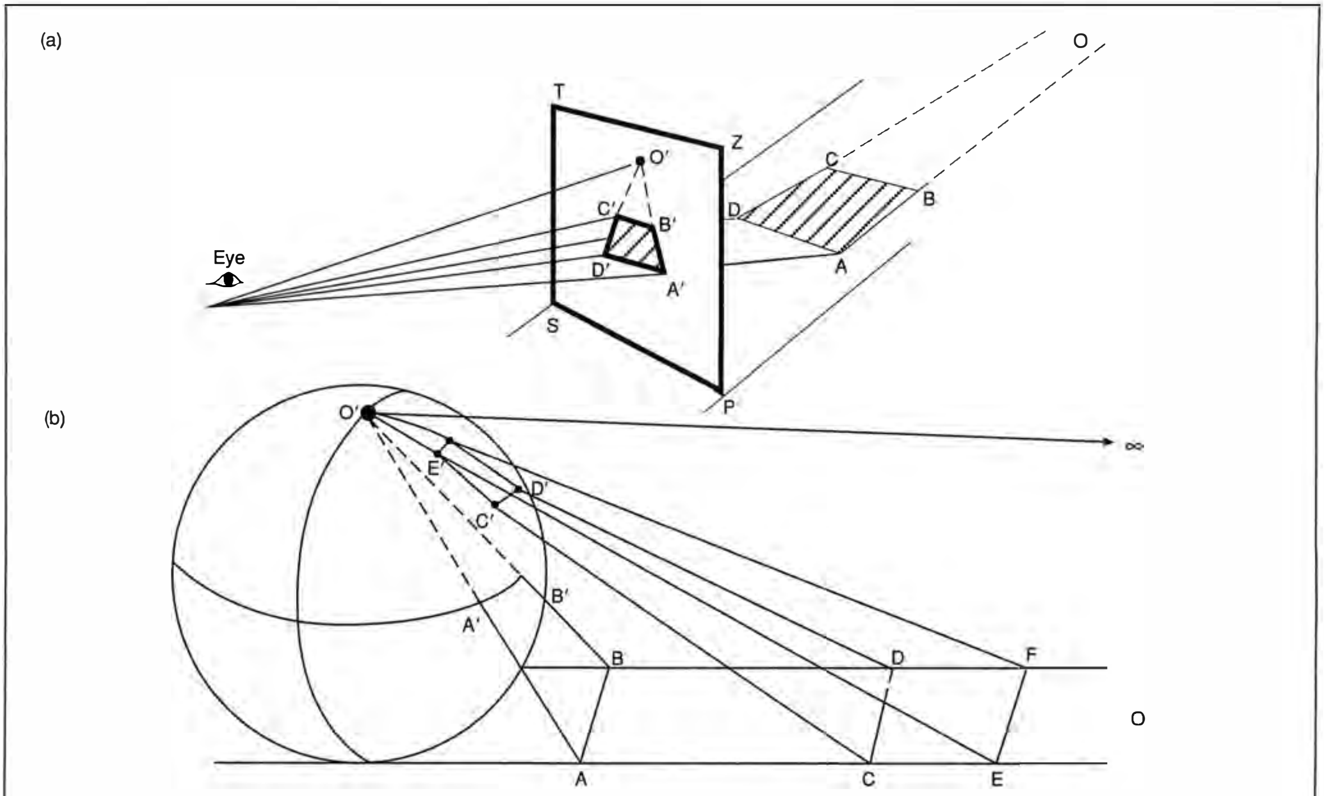

Figure 2
TRANSFORMATION OF EUCLIDEAN PLANES INTO PROJECTIVE PLANES
In (a), the Euclidean plane, the indefinite plane represented by the square ABCD, is transformed into a projective plane, A′B′C′D′, which is closed, or bounded, by O′, the point at infinity. Leibniz called the unbounded Euclidean plane an immensum.

In (b), the Euclidean plane is represented by the parallel lines AB, CD, EF, and so on. The projection onto the sphere represents the bounding or closure of the projective plane. The point at infinity, O′, is now the north pole of the sphere.

to make quantitative measures, one has *already* to assume an *outside* entity of one *higher* dimension and specific properties. The motion of a line presupposes and reveals a higher dimension: a surface! The motion of figures presupposes a space! This cannot be kept implicit and hidden. The *characteristic* of the space determines the forms of motion and the measuring rod to be used. Euclid had implicitly assumed, in the case of motion of rigid lines, an infinite *plane of constant and null curvature;* only that assured that the line did not change in form and length when moved to compare two things. For this reason, Leibniz realized how important it was that, "Before dealing with figure, we must deal with space itself and with the point. . . ."[48]

The process of discovering, how to determine the higher dimensional entity, to define its property out of *recognized* types of changes, is the history of mathematics itself. To us, here, it is only of interest to stress that for Euclid and Descartes, the space was considered *homogeneous* with respect to its parts. In this specific case, it means that the elements are rigid atoms which never change, and the whole can be completely determined as the sum of its parts: 2 = 1 + 1.

Leibniz discovered, that many physical realities and transformations in *forms,* were excluded by such continuity. This indicated to him that the reality, both of nature and the human mind, is higher than any "one" mathematics. Euclid's axioms were not absolute laws, but represented a changeable correct hypothesis about a type of measurement.[49] Obviously then, also Descartes's coordinates could not assure the measurement of the "universe," and Newton's "space" was not an *absolute.* We will see Leibniz's explicit formulation of this; but we wish to show, with a few chosen examples, how he proved the relativity of any axiomatic system, by, variously, constructing, or hinting at, new forms of calculus and geometry.

The Continuity of Forms: *Similarity*

In Paris, Leibniz studied Pascal's projective geometry, which had been developed out of Italian pictorial perspective. The projective plane has the specificity of being a bounded infinite, while Euclid's plane is indefinite, because of the hidden assumption we saw above (Figure 2).

Leibniz already knew of this through Plato, Cusa, Kepler, and so on; so, he recognized it easily, as in notes of 1676: "Hence it is clear that the infinite is other than the unbounded. . . . This unbounded infinite should more rightly be called the immensum."[50]

The characteristics of this new space, define continuity for other types of changes. In the simplest example, one can see

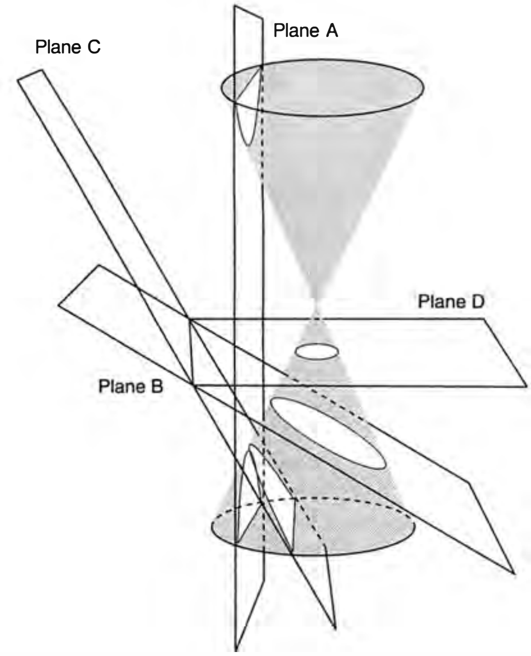

Figure 3
TRANSFORMATION OF A CIRCLE INTO AN ELLIPSE
A cone permits transformation of a circle into an ellipse, using the concepts of situs *and* similarity *of forms. The plane* D, *which is parallel to the base of the cone, cuts it into a circle. Rotating the plane,* B, *creates an ellipse, while rotating it further creates the hyperbola,* C, *and the parabola* A.

how a cone permits transformation of a circle into an ellipse (Figure 3). In this transformation, we do not use concepts of equality or numerical differences, as in Euclid; rather, as Leibniz says, we must employ the concepts of *situs* and *similarity* (of forms). Leibniz could have simply stayed at that new level; but, he realized that conics are only the simplest among a family of boundary spaces which express continuity. So, while studying Pascal, he wrote:

> [T]he *method of discovery* . . . through *situs,* thus without calculation, is based on the simultaneous grasping of a plurality sharing a common situation, which occurs either by means of a certain figure . . . or by motion or an alteration . . . among the motions and alterations, we see that the alteration of appearance or optical transformation of figures is very usefully employed; we must see whether, by this means, we cannot go *beyond the cone, to higher properties.*[51]

The search for higher properties, indeed, led Leibniz to a series of major discoveries, including the infinitesimal calculus and analysis situs (the "calculus of situation"[52]). The latter, reported in a text sent to Huygens in 1679,[53] was, according to the official story, rediscovered only in 1833, and elaborated as "vector calculus" by Hermann Grassmann. In reality, elements of Leibniz's intuitions had already been transmitted by Ehler to Euler, who omitted his debt to Leibniz, when he developed one of the many aspects of modern topology. But, Leibniz's analysis situs is exhausted neither by Grassmann's, nor Euler's interpretations of it. Other mathematicians, such as Monge, Carnot, Gauss, Poncelet, Riemann,[54] and so forth, each of them with some variation, developed and referenced explicitly Leibniz's concept of "situs." This use of many names for a similar concept, indicates to us, something of the real concept of "situs" in Leibniz's own thinking.

But, before we get to that, let us consider some other generalizations made by Leibniz. As we have seen, he had realized that he had to face directly the concepts of space and of the point itself, that is, the maximum-minimum. In his manuscripts, before 1679, one can follow how Leibniz shifted, from the idea of "point" as "rigid atom," to "point" as "variable ordered interval," or situs. This (which cannot be elaborated in these few pages), appears under the different mathematical notions of differential, geodetic, minimal action, and so on, each postulating a different class of transformations, continuity, conservation, and so on. For example he devised, among others, three classes of transformations:

(1) The motion of a "rigid line interval," presupposing a plane.

(2) The motion of a "rigid arc's interval," presupposing a sphere.

[Gauss later will identify both (1) and (2) as motion on two types of *constant curvature,* zero or positive.]

(3) The motion of a *variable* interval, presupposing a variable curvature. Leibniz wrote: "When I speak of fixed points, it is not necessary to suppose that those points have necessarily a fixed distance from each other; rather, I think of them as attached by a string that can be made longer or shorter."[55]

This last concept is the nearest to what Riemann was referring to when he wrote,

> Analysis Situs . . . used by Leibniz, although perhaps not entirely with the same significance . . . may well designate a part of the theory of continuous entities which treats them not as existing independently of their positions and measurable by one another but, on the

48. Gottfried Leibniz, On the Elements of Natural Science (unpublished manuscript toward a book, 1682-1684), "The Plan of the Book," Loemker, p. 278.
49. Cf. Bernhard Riemann, note 47.
50. Gottfried Leibniz. Paris Notes, Loemker, p. 159. The infinite is other than the unbounded, but there is also an unbounded infinite.
51. Pierre Costabel. "Notes de Leibniz sur les coniques de Pascal," in *L'oeuvre scientifique de Pascal* (Paris: P.U.F., 1964).
52. It is referred to thus, in "On Analysis Situs," Loemker, p. 257.
53. See Leibniz's discussion of a "characteristica geometrica" in a supplement to his letter to Huygens of Sept. 8, 1679, Loemker, p. 249. It is also published with other interesting Leibniz manuscripts in Gottfried Leibniz, *La caractéristique géométrique,* Latin text established and annotated, with an interesting historical introduction, by Javier Echeverria; French translation by Marc Parmentier (Paris: Vrin, 1995).
54. Most famously, from Section 2 of Riemann's 1857 "Theorie der Abel'schen Functionen," the celebrated "Lehrsätze aus der analysis situs für die Theorie der Integrale von zweigliedrigen vollständigen Differentialien Gesammelte Mathematische Werke, pp. 91-96. Most relevant for our historical discussion of the matter of method here, is the notable opening paragraph, on page 91.
55. Gottfried Leibniz. *De la Methode de l'universalité,* circa 1674, in *Opuscules et Fragments inédits de Leibniz,* by Louis Couturat (Hildesheim: G. Olms Verlag, 1966), p. 128.

contrary, entirely disregarding the metrical relations, investigates their local . . . properties.[56]

To come to a preliminary conclusion, after this brief history, we can already see, that the form of mathematical *continuity* (a "not-change" to measure changes), has, for the moment, changed constantly. But Leibniz has no problem with that; for him causality is not representable in any single mathematical lattice, not even in space-time itself! In 1714, when summarizing his concepts in opposition to Newton's absolute space-time, and before Einstein gave Newton new clothing, he wrote:

> I have demonstrated that space is nothing else but an *order* of the existence of things observed as existing together . . . besides that there is no real space out of the material universe. . . .[57]

And,

> *Time is the order of existence of those things which are not simultaneous.* Thus time is the universal order of changes when we do not take into consideration the particular kinds of change [emphasis in original].[58]

Space-time becomes a variable causal ordering of variable action-intervals. A flux, but with a sufficient reason, a *logos,* a continuity, *indissociable* from the human power of invention, from the power to find intelligible higher order of "before-after," "higher-lower," and "reasons." This causality cannot be completely expressed in any form of homogeneous combination of finite elements taken as *complete and consistent,* because it is located in the higher dimensional boundary; and, as Leibniz says, "It is clear . . . that a boundary is *not homogeneous* with what it bounds. . . ."[59]

In mathematics, this is expressed by the appearance of different forms of *incommensurables.* For example, in the case in which the number π is measured by the other numbers 1,2,3,4,. . ., π is incommensurable, because it reflects, explicitly, the specific *higher boundary* of that domain (the circle measured by a line). In mathematics, relative continuity, or commensurability, can be reestablished in such cases, if a creative being like Leibniz discovers continuously new forms of measurement. But with man *explicitly* present at the center of the world measured by mathematics, the higher *boundary* will not be exhausted by mathematics, as Cantor will formally prove.[60] We have to look somewhere else.

Beyond Mathematics

Leibniz wrote: "The theory of similarities or of forms lies beyond mathematics and must be sought in metaphysics. Yet it has many uses in mathematics also. . . ."[61] and, ". . . there is an art of analysis more inclusive than mathematics, from which mathematical science derives its most beautiful methods. To [present] this I shall have to introduce a somewhat higher order of principles."[62]

What does he mean by "metaphysics"? Is this just "logic," as some interpreters of Leibniz have assumed? Is formal logic that which Leibniz signifies by his use of the term "characteristica universalis"? Kurt Gödel supplied a formal proof of the impossibility also of that assumption,[63] but Leibniz had already clearly said that the boundary is outside, and higher than, metrics, curvatures, topologies, logical lattices, theories, and so on:

> Besides the world or aggregate of finite things, there is a certain One which is dominant, not only . . . as the Ego itself is dominant in my body, but also by a much higher reason. . . . For a sufficient reason for existence cannot be found merely in any one individual thing or even in the whole aggregate and series of things. . . .
>
> The reasons for the world therefore lie in something extramundane, different from the chain of states or series of things whose aggregate constitutes the world.[64]

The Difference

Our continuity, our "one," is escaping to a higher and higher level. Man's world does not allow itself to be measured by any final simple yardstick. The higher boundary seems to be higher than ever, and if we were to leave it there, in its Kantian transcendence, we could explain changes only through the occult, as chance, or as the fruit of a pagan's miracles. Leibniz is laughing at us, and hinting, that probably we have missed something concerning his idea of "situs": Situs is about forms, or what makes things really *different,* he says.[65] To clarify what makes things really different, he writes, in another work:

> *[T]here cannot be two individual things in nature which differ only numerically.* For surely it must be possible to give a reason why they are different, and this must be sought in some differences within themselves. . . . So perfect similarity occurs only in incomplete and abstract concepts, where matters are conceived, not in their totality but according to a certain single viewpoint, as when we consider only figures and neglect the figured matter. So geometry is right in studying similar triangles, even though two perfectly similar material triangles are never found. And although gold . . . or salt, and many liquids, may be taken for homogeneous bodies, this can be admitted only as concerns the senses, and not as if it were true in an exact sense.
>
> *The complete or perfect concept of an individual substance involves all its predicates, past, present, and future. . . .*
>
> *Every individual substance involves the whole universe in its perfect concept. . . .*
>
> *There is no corporeal substance in which there is nothing but extension, or magnitude, figure and their variations.* For otherwise there could exist two corporeal substances perfectly similar to each other, which is absurd. Hence it follows that there is something in corporeal substances analogous to the soul, which is commonly called form. . . .
>
> [It follows that] Space, time, extension, and motion are not things but well-founded modes of our consideration.[66]

This brings us back into the world; but, now, the illusion that mechanics can give a better answer than mathematics, respecting causality, has to be discarded. Leibniz says, that mechanics avoids that "Jupiter who thunders," the *deus ex machina* who is essential for the universe as defined by Descartes and Newton, only in this way:

> In my judgment the best answer, which satisfies piety and science alike, is to acknowledge that all phenomena are indeed to be explained by mechanical efficient causes but that these mechanical laws are themselves to be derived in general from *higher reasons* . . . Once this is established, we need not admit entelechies any more than we admit superfluous faculties or inexplicable sympathies. . . .[67]

The 'Vis Viva'

The continuity of the physical world has always been associated with the "conservation" of something. Descartes thought of the conservation of *quantity* of *motion,* as representable by a line. Leibniz discovered this error and introduced the conservation of "vis viva," that is, simply said, the conservation of *qualitative changes* of motions, representable as a curve. As Darwin had misused Leibniz's idea of general continuity, so Darwin's friend Hermann Helmholtz reduced *vis viva* to "energy," as a fixed substance. But Leibniz, in mathematics, as in physics, never talked about conservation of some "thing": motion, metric, geometry, and so on. Conservation of *vis viva* has the same meaning as the "conservation of continuity" by *invention,* after the appearance of the incommensurable in the domain of numbers.

In mechanics, the arithmetically "incommensurable" is expressed in the form of *discontinuity:* for example, mechanical shocks. It is around the issue of shocks, that Descartes's and Newton's mechanics loses its notion of conservation, and of causality. For Leibniz, that was not an indication of the irrationality of the world, but, of a shortfall of Newtonian mechanics! So, he sought a new form of transformations, capable of re-establishing causality. Specifically, he introduced the concept of transformation of motions into *internal* changes of configuration (elastic vibration), or *potential energy.*

We really have to see that the two concepts, "situs" and "vis viva," have the same root. Situs is what "makes a thing really different," or the minimal "ordered interval." In Leibniz's calculus, this appears as the "differential." In other words, the points are not finite objects, like an X or a Y; they form a *unit* as ($X \leftrightarrow Y$), where the operational symbol, $\leftrightarrow$, represents what is essential, indicating a type of transformation. This unit, $\leftrightarrow$, reflects the characteristic of the "higher boundary"; as such, it is not reducible to any final homogenization, or to a sum of the elements transformed. In that sense, it is never a constant, or a simple continuity, or "linearity in the small."

This is often misunderstood, because one confuses Leibniz's "situs" which is a "bounded infinite interval" with what, after Augustin Cauchy, became the "derivatives": that is, a form of linear *measure* of that interval.[68] Unfortunately, the notion of Leibniz's differentials learned in school is derived from the teaching of Cauchy's calculus, not Leibniz's.

The difference is clear if one keeps in mind, Leibniz's own development of a *different* form of measurement, or his statement about that "higher order of infinities," which, later, Cantor transformed into his ordered transfinites. Any linearization, any constant, implies a homogeneous space, which Leibniz discarded as not adequate for physics, but—and this is useful—any measure (with lines or curves) implies a linearization!

In mechanics, Leibniz used the same concepts. The "atom" of the physical space becomes a "quantum of change," while the configuration of such elements, the general situs, becomes the potential energy. The conservation of "vis viva" is then the conservation of the "motive power" reflected in all the possible variations of the intervals ($\leftrightarrow$), and, consequently, in the change in the configuration or potential. This can be seen at two levels:

On level "A": At the level of any measurement, this becomes what Carnot called conservation of the "geometrical motions" through use of *geodetic* or *minimal* paths, or *minimal* intervals ($a \leftrightarrow b$). This means, a search for the most efficient path for the transformation (energy-input $\leftrightarrow$ work-output). This notion is subsumed under the name of *machine,* or, for a class of the same type of machines, under the name of a *technology.* It is impossible for any such technologies to gain a *surplus* of energy by themselves. That is to say, that energy is considered conserved. But, in reality, at this simple level, as causality was

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56. Bemhard Riemann, *Gesammelte Mathematische Werke,* p. 91.
57. Gottfried Leibniz. Fifth letter to Samuel Clarke, numbered paragraph 29, Loemker, p. 700.
58. Gottfried Leibniz. "The Metaphysical Foundations of Mathematics" (after 1714), Loemker, p. 666.
59. *Ibid.,* 668.
60. Dino de Paoli. "A Refutation of Artificial Intelligence: Georg Cantor's Contribution to the Study of Human Mind," *21st Century,* Summer 1991, p. 43; "Gödel, Cantor, and Leibniz: Mathematics and the Paradoxical in Nature," *21st Century,* Summer 1997, p. 22; and, for the Cantor-Haeckel controversy, "Georg Cantor's Contribution to a New Renaissance," *Executive Intelligence Review,* Vol. 22, No. 31 (Aug. 4, 1995), p. 24.
61. Gottfried Leibniz, "On Analysis Situs," Loemker, p. 254.
62. Gottfried Leibniz. "The Metaphysical Foundations of Mathematics" (after 1714), Loemker, p. 666.
63. Dino de Paoli. "Gödel, Cantor, and Leibniz: Mathematics and the Paradoxical in Nature," *21st Century,* Summer 1997, p. 25.
64. Gottfried Leibniz, "On The Radical Origination of Things" (1697), Loemker, pp. 486-487.
65. Gottfried Leibniz. Letter to Walter von Tschirnhaus (1697).
66. Gottfried Leibniz. "First Truths" (ca. 1680-84), Loemker, pp. 268-269.
67. Gottfried Leibniz, "Specimen Dynamicum" (1695), Loemker, p. 441.
68. Dino de Paoli. "Georg Cantor's Contribution to a New Renaissance," *Executive Intelligence Review,* Aug. 4, 1995, p. 24;"Lazare Carnot's Grand Strategy for Political Victory," *Executive Intelligence Review,* Sept. 20, 1996, p. 30.

See Pierre Beaudry on how Cauchy, using Ockham's razor, castrated the Leibniz calculus: "The Bourbon Conspiracy That Wrecked France's Ecole Polytechnique," *Executive Intelligence Review,* June 20, 1997. Following the circulation of the celebrated paper, "The Principles of pure D-ism, in opposition to the Dot-age of the University," of Cambridge University's John Herschel and Charles Babbage, not even in England could one continue to maintain plausibly the pretense, that Isaac Newton had produced a "calculus" to rival Leibniz's earlier design. In France, the hoax of the Newton "calculus," had been thoroughly aired in all leading scientific circles during the course of the 18th century. So, in France, with the blessing of King Louis XVIII, and his Russian master, Carlo Pozzo di Borgo, Augustin Cauchy removed the reproductive organs from the Leibniz calculus, pleasing the French positivists very much, and finding approbation even in Isaac Newton's old *alma mater.* Essentially, Cauchy's notorious "limit theorem" presumed what Nicholas of Cusa, as a forerunner of Leibniz, had already shown to be absurd, in his A.D. 1441 *De Docta Ignorantia:* that it was absurd to ignore the functional implications of the species-distinction between a boundary; for example, the circumference of a circle, and the circumference of an inscribed regular polygon of a very large number of sides. The effect of this castration, was to supply a fraudulent appearance of rationality to today's still-hegemonic error, the presumption that the universe is linearized in the extremely small.

not conserved, and, as continuity was not conserved, energy, if considered in this way, is also not conserved in *physical* spaces. Leibniz clearly had recognized, and used against Newton's mechanics, what the modern teaching of physics has rediscovered as *entropy.*

On level "B": The causal relations, expressed in a technology, are *necessary* and determined (from cause "X" follows, necessarily, effect "Y"); but, these relations are *not sufficient.* The sufficient reason, the real causality, lies in the power to conserve activity, by changing the form of the (input ↔ output) itself. When one of such types of changes occurs, it becomes visible by its *incommensurability* with the metrics used for measuring on level "A." We have, thus, changes in the total function defining the technology.

We will clarify this in the concluding section.

The concept of a universal (↔), an individual, irreducible, not-extended, quantum of change, or situs, valid for man's world, is recapitulated by Leibniz under the name of *monad.*

This idea of a not-extended existence, a "change" related to the higher boundary, is inconceivable within today's mechanistic tradition of Newton, Descartes, and Euler. But, had 19th century positivism not marginalized Leibniz's idea, we would have had less epistemological difficulty when the concept of quantum of action was rediscovered *experimentally,* by Max Planck. The physical space is not representable even by the very flexible "points linked by strings" of the early Leibniz, and the equivalent of Einstein. At the stage of Leibniz's development on which our attention is focussed here, he is now indicating, that "extension" is only one of the many human "modes of measure." It is not an objective thing, with which one can associate final causality. The space-time of (↔) does not exist in any of the given fixed modes of consideration.

Freedom exists, as many people were forced to recognize, when they were confronted by biological "mutations" or "quantum jumps"; but, customarily, they took the term "freedom" as signifying arbitrary changes. Like Euclid, they also overlooked the "higher boundary." The study of human mind, the third level, where another kind of "mutations" occur, could have helped to clarify the notion of causality.

From Mere *Individuality* to Individual *Personality*

> [S]ouls in general are living mirrors or images of the universe of created beings, while spirits are also images of divinity itself or of the author of nature, . . . each spirit being like a little divinity within its own sphere.
> —The Monadology[69]

We can now better comprehend Pascal: the search for the totality brought us to the notion of difference, and this led us to the one that makes the difference: free with respect to any homogeneous world around him, because he is part of a higher boundary. Einstein's notion of "free invention," makes it futile to seek a *final measure* of man's world. But, says Leibniz, if we can not simply measure the "higher boundary" as number, or extension, we can, nevertheless, discover its necessary existence and implication:

> This consideration [singularities in geometry and experimental science] also shows that there is *an inborn light within us.* For since the senses and induction can never teach us truths that are fully universal, nor what is absolutely necessary, but only what is, and what is found in particular examples, and since, nonetheless, we know some universal and necessary truths in the sciences, a privilege we have over the beasts, it follows that we have derived these necessary truths, in part, from what is within us. Thus one can lead a child to them in the way Socrates did, by simple questions . . . [emphasis in original][70]

The inborn light was known to many before Leibniz:

> I believe [this] with Plato, . . . the Schoolmen, and with *all* those who find this meaning in the passage of St. Paul (Rom. 2:15) where he states that the law of God is written in our hearts.[71]

The general characteristic is there, when discovered, trained and acted upon *for* the necessary changes in our world, when one can love that light, inborn in us, which makes us persons, not merely self-interested individuals.

In conclusion, in the final pages, we wish to see how this necessary law, which makes us "privileged" over the beast, expresses itself as a measure of our only way to live humanly in a non-Darwinian world—in a world which we did not create, and which is not a toy for our pleasures.

Part 3. The Ontological Difference Which Is Man

Let us imagine the following two situations, without, for the moment, any claim to precision:

World "A": 50,000 B.C.; 1 million humans; many chimpanzees; many trees; and, for a touch of charm, a water-powered computer which has defeated the best local human chess-player.

World "B": hopefully, tomorrow; 10 billions humans with a colony on Mars; many chimpanzees, many trees, and a pile of rubbish.

Let us now make what Leibniz called a simultaneous comparison of those two worlds, as if we could transport "A" into "B." This should assist in constructing something like the following:

(1) The trees easily find a common denominator.

(2) The chimpanzees also have no major obstacles in communicating, fighting, playing, and so on; but, perhaps some "A" and "B" chimps *can not* produce offspring between them.

(3) The computer of "A" is the pile of rubbish in "B." Life did not produce nor conserve it; man produced it, but, enraged about the defeat at chess, did not evolve it, either. Entropy took care of it.

(4) The two sets of humans have big problems in relating to each other. They could produce offspring between them, but, the "A" people are frightened and enthusiastic at the same

69. Gottfried Leibniz, "The Monadology," Loemker, p. 651.
70. Gottfried Leibniz. Letter to Queen Sophie Charlotte on What Is Independent of Sense and Matter, 1702, in G.W. Leibniz, *Philosophical Essays,* edited and translated by Roger Ariew and Daniel Garber (Indianapolis: Hackett Publishing Co., 1989), p. 191.
71. Gottfried Leibniz. *New Essays Concerning Human Understanding,* translated by P. Remnant and J. Bennett (Cambridge: Cambridge University Press, 1981), Introduction.

Bill Ingalls/NASA

Life's conservation is assured only through a qualitative discontinuity: the formation of individuals with new types of characteristics, linked to the use of new types of energy or resources. Neither educated chimpanzees, nor primitive cultures, can build fusion-propelled rockets and colonize the Moon and Mars. Here, schoolchildren in Tampa, Fla., outfitted for a mission on their bus, which is outfitted like a Space Shuttle orbiter.

time; they are prostrate before a spokeswoman of the "B" people. The people of "A" think she is a *goddess!* Not for her beauty, but, because she was seen landing from the sky, because she talks about "burning water" (fusion energy), and about other worlds up in the sky, and so on. Can we establish continuity between man and "goddess"?

From the standpoint of the available visible elements, "No!" The humans of "A" and of "B" are *incommensurable,* although in matters such as Engelian *hands,* and even the rest of the body, they are practically the same in extension and form. Nonetheless, the "goddess" will not make herself coherently intelligible, if she uses only external means of comparison: bodies, rockets, airplanes, wheels, water, and so forth. She will succeed only if she herself is conscious of the real, hidden *similarity.* Only if she is able to make clear to the "A" people the "godliness" that human beings have, and always *had* in themselves! Only by making explicit the existence of the *real* Invisible Hand, the specificity of human creative cognition, can continuity be reestablished.

The simple schema above, points not only to the discontinuity in the development of human culture; it also hints at some different kind of discontinuity in animal development. We wish to see a bit better the difference, and the similarity, between the biological and the cultural levels.

The Biological Monads

Let us assume that we observe a young, living cell: It will grow, age, die. But, life can continue! Not by simple time-reversal (once aged, one does not survive by going back to childhood), but through production of offspring. This represents a space-time *discontinuity,* that is, the new cannot be obtained by any simple extension of the old. If, then, reproduction continues in the same form, within the same *species* of change, life will reach another limiting point, and could, again, face extinction.

Life's conservation is assured only through a new dimension, a new qualitative discontinuity: mutation, formation of individuals with new types of characteristics, the latter linked to the use of new types of energy or resources. To sum it up, a cell, to access necessary new energy levels (involving hydrogen, oxygen, photosynthesis, and so on), to move in the Earth, water, and air, had to *change* genetically. The total process seen simultaneously, would appear as a series of different orders of genetic discontinuities. The causal continuity, the higher boundary, is not recognizable in the visible, mere similarity among individuals, but, especially, in the anomalies added by their *differences,* as translated into an increase of the reproductive power of *life.*

To measure this increase, one cannot concentrate only on the energy or metabolic balance (input/output) of a biological individual, or, of a species. That can indicate the minimal condition for a static equilibrium; but is not sufficient to grasp the reproductive potential of life. In Figure 4, we try to represent the full process schematically; we see that any simple expansion (line *L*) of individuals, or species, reaches a limit (*K*), the so-called ecological "carrying capacity," which, in turn, indicates the maximum possible population density. In contrast to Malthus's assumptions, even for animals, *K* is not necessarily *constant;* on the contrary, *it is defined as a variable*—K_1, K_2, and so on. Only this "vertical" motion of *K,* indicates the increase in the reproductive powers, and can be called an increase in the "economy" of life.

It is clear that these increases, these "absolute" changes, are not the domain, or the responsibility, of the biological individual or species. The agency is solely what we called "Life," through the process of inner "genetic" changes *of the individuals,* with the resulting macro-speciation. A process which appears to observers as precisely "indeterminate," as if "above" the simple energy balance of the individual's environment, lies in the domain of the individual's apparent decision to generate higher animals. The biological minimal element, as carrier of such a "quantum of change," could be considered as a kind of Leibnizian monad, never equal to another, nor homogeneous with whatever fixed totality we use to classify it.

Some animal societies and proto-cultures exist, but at that level, they have no capability for expanding their economies. At best, all they can do, is to discover some better, non-genetic adaptation to the given milieu, to increase their share. The animal is culturally constant, and biologically variable.

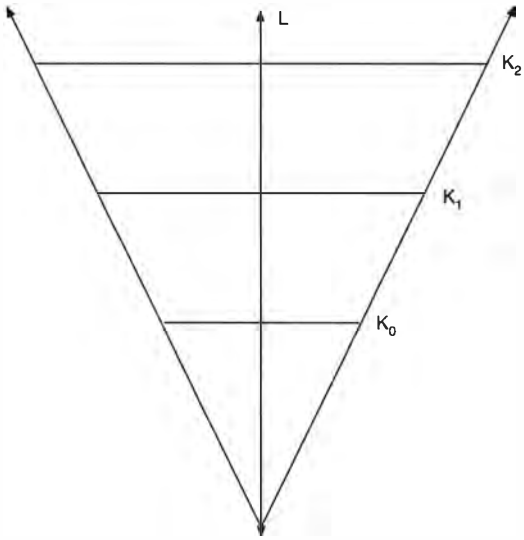


Figure 4
SCHEMATIC OF REPRODUCTIVE POTENTIAL OF LIFE
When any simple expansion of individuals or species reaches a supposed limit, K, *the so-called carrying capacity, in reality, contrary to Malthus's assumptions, this limit is variable. This vertical motion of* K—K_0, K_1, K_2. . . *—indicates the increase in reproductive powers—an increase in the "economy" of life.*

With Friedrich Schiller, we could now say:

> Nature begins with Man no better than with the rest of her works: she acts for him where he cannot yet act as a free intelligence for himself. But it is just this that constitutes his humanity, that he does not rest satisfied with what Nature has made of him, but possesses the capacity of retracing again, with his reason, the steps which she anticipated with him, of remodelling the work of need into a work of his free choice, and of elevating physical into moral necessity.[72]

The Spirit Monads

Man went from water mills to water-based fusion-power, he moved on Earth, in water, in the air, to new planets, without any major genetic change. The total process, seen in simultaneity, would appear as one biological individual, expressed in a series of cultural discontinuities. The causal continuity, the higher boundary, is translated into the increase in the creative power of cognition, reflected in each single human being. Man is biologically constant and culturally variable. In Figure 5, we see that the ecological "carrying capacity" represented by K_1, K_2,. . ., here is made *variable,* with an increase in human reproductive powers and population density, through the creation of new *species* of technologies, discovered by individual human beings.

The discontinuity of the process can be quickly grasped with an example. A windmill-based economy, no matter how much one increases the size of windmills, *can not* bring man to the Moon! There are intrinsic limits, which also define the maximum possible density of the population. An economy based on fusion energy can bring man even to Mars, and allow an increase in the population density. The fusion economy becomes incommensurable, if measured with static parameters linked to the wind economy, and so does its workforce and culture.

As for life, so for human economy, the measure of the reproductive power can not be based on simple balances based on an individual machine's, or a technological level's relation to population-density. Any given technology always implies a possible overpopulation, in prehistory, or today. But, now, it is man himself, who *can* avoid reaching Malthusian-Darwinian limits, *can* avoid the circumstances which would impel him to compete with one another for adequate living space, or, to kill one another for it. Man, unlike any other biological species of individual, does not have to wait for life to produce a biological mutation to enable the use of new resources. Man has the power, the agency, to directly *increase* the ecological carrying capacity as—but more than—life itself does.

If we really want to make meaningful comparisons, then we cannot compare man with other kinds of biological individuals; we must compare man as a species with what Leibniz called the Life-monad itself. Our continuation of the vertical motion of *K,* indicates our conscious contribution to the increase in the reproductive powers of the total economy of the human world. Our contribution to such "absolute" changes, the increase of "carrying capacity," is the result of an inner process, the "inborn light within us," the individual power of creative cognition.

"We cannot wait and react. We can defend our world only by continuously enlarging it, through a culture which takes seriously the meaning of the 'inborn light.' "

As human individuals, we each also participate in, and are, from within, necessitated by a higher domain which is no longer merely life. As such we are absolutely indispensable, and not a simply substitutable part of any social or biological totality: each newborn is a specific contribution, and each death a terrible loss. In that sense, we also can, each, be seen as a Leibnizian monad, but a spiritual monad. It is this which will appear indeterminate, and "outside" any measurement of the economy which takes into consideration only technological levels, or biological man in relation to the environment.

This light within us, cannot be either created, or destroyed, socially, or biologically. But its use, transmission, consciousness, increase, or paralysis, is accomplished socially through culture, and it is the relative power to foster—or even to reduce—this potential which defines the differences among cultures. The height of a civilization does not tell us automati-

72. Friedrich Schiller, *On the Aesthetic Education of Man in a Series of Letters,* translated by Reginald Snell (New York: Frederick Ungar Publishing Co., 1965), Third Letter, pp. 27-28.

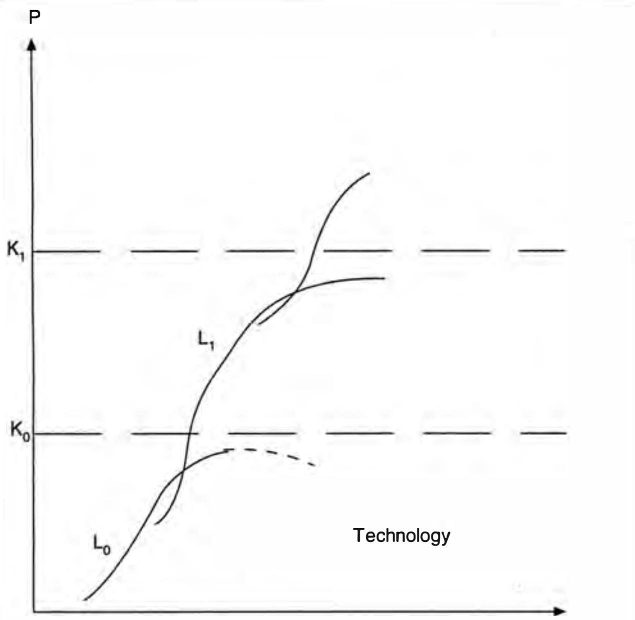


Figure 5
TECHNOLOGY'S IMPACT ON POTENTIAL POPULATION DENSITY
The ecological "carrying capacity," represented by K_1, K_2, . . ., *increases discontinuously, as a result of man's ability to discover new species of technology.*

cally its potential to survive, as we know from history. The simple sum of machines and the energy level or technological level reached, tell us only the given "carrying capacity," the relative population density. This is crucial, but if man stops acting to change it, to increase it, nature will take over, by revealing collapses, overpopulation, and so forth. What indicates the quality of a culture, is the potential it has to learn, to value, to love and create the conditions for the use of the inner human resource needed at *any* level of development, needed to make the necessary *increases* in the relative population density.

The motivation to act in this direction, cannot be left to simple impulse, nor self-interest which dissociates truth from emotion as a pagan ritual does. Even merely good impulses, like a strong response to a catastrophe, do not suffice.

Einstein once wrote that his first major discovery (special relativity), was stimulated by the need to solve an *anomaly* in Newtonian physics. But, he added, there was *no visible anomaly* which pushed him to his second major discovery (general relativity). He arrived at it after he had decided to see where the *limit* of the first discovery lay: where the first theory, as any theory, would break down. A society, in a sense, has the same moral imperative to search for truth. To be able not simply to react to, but to anticipate catastrophes, one must *know* in advance.

We are not able to predict, as if in a magic world, or in a Newtonian determinism; but, one can see where a given level of carrying capacity breaks down. This is indicated not only by the already visible human disasters around us: migrations, poverty, starvation, but, also, for example, by the fact that earthquakes can still kill thousands of people. We have to be able to know what *we are at present not able to do,* given no better than present knowledge. This, alone, can tell us where we stand.

We see that life does not wait upon the bureaucracy. We know about terrible new viruses, about bacteria that have become resistant to antibiotics. So we can never say: "We have arrived, we can just administer." On the contrary, we have to keep alive the flame of the continuous increase in our cultural potential, and its realization as increase in carrying capacity. This is not a simple social automatism, nor a matter only for the science department; it involves the total human being, all the departments, but, especially, it requires the risk of allowing man to be determined *from the inside.*

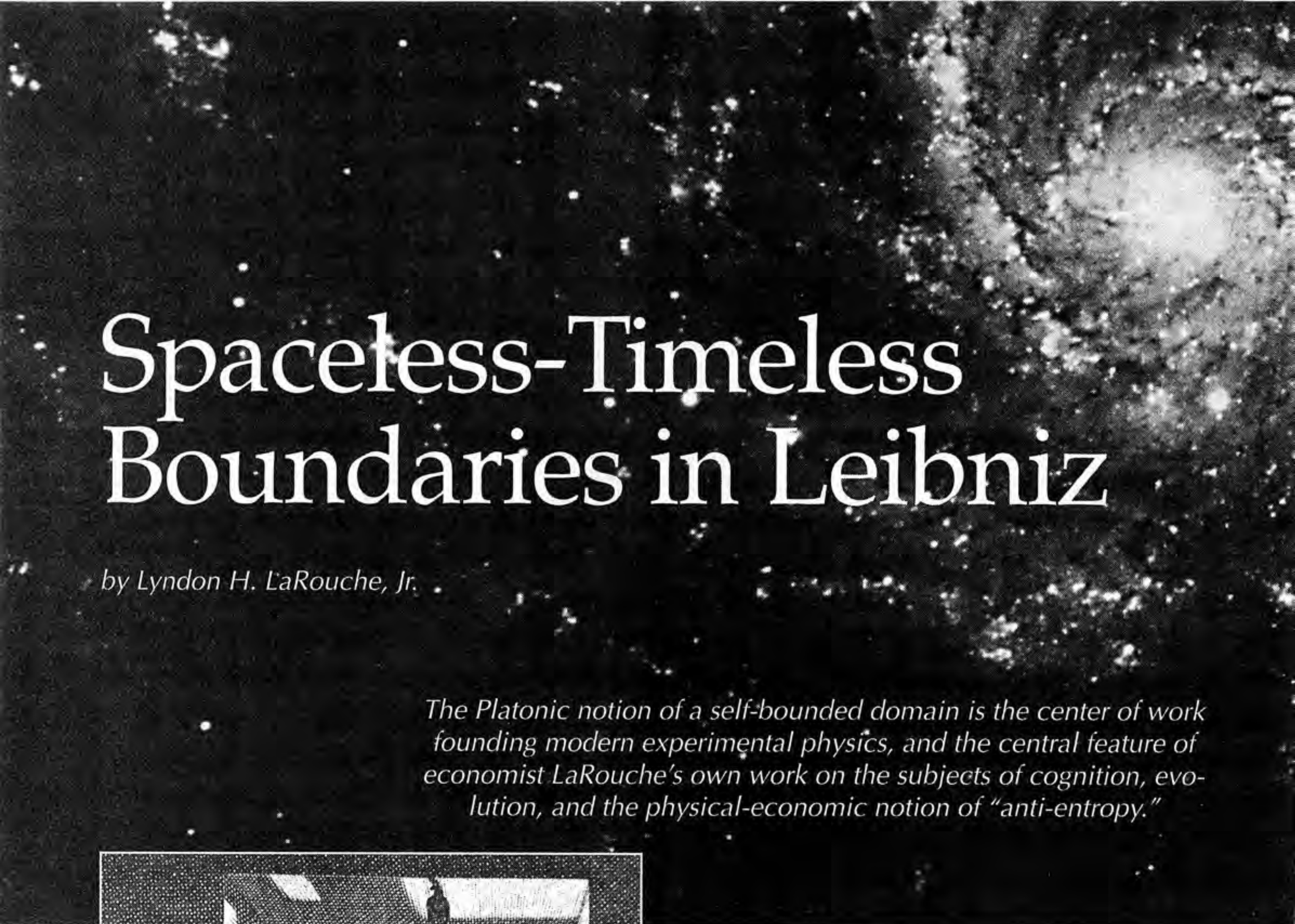
If the universe were a machine, or if we were just objects of natural evolution, we would need no moral responsibility—the world would simply decide for us. In such a world, our economy, culture, and judgment could be a simple artificial convention. As many already do today, one could concentrate only on the pleasure of exercising power over other people. But, that is not our world; that is a suicidal choice of dominant political ideology.

"Only man has learned the intrinsic limit of the protracted use of any simple discovered tool or theory over many generations. Only man has discovered that he had to learn how to willfully evolve superseding discoveries, tools or theories."

In conclusion, let me ask: Is *life,* as we know it on Earth, self-sufficient? A collision with an asteroid, a change in Earth's magnetic field, the evolution of the Sun, or other causes, could dramatically change, or destroy, the biological life on our planet. In any such event, no chimp could help; but neither could a culture, which had gone back to the use of windmills, nor an economic ideology in which an imaginary President might declare: "Dear citizens, we know that a large comet is about to hit the Earth. You can follow it on the Internet! *We have* the technology to stop it, but we are not able to incur any more debt; *we have no money* to stop it!"

We cannot wait and react. We can defend our world only by continuously enlarging it, through a culture which takes seriously the meaning of the "inborn light." The monads of *vis viva,* life, and cognition are different, but the differences, and their pre-established harmony, tell us, although in but a glimpse, of the necessity and the joys linked to the higher boundary of the best of all possible worlds.

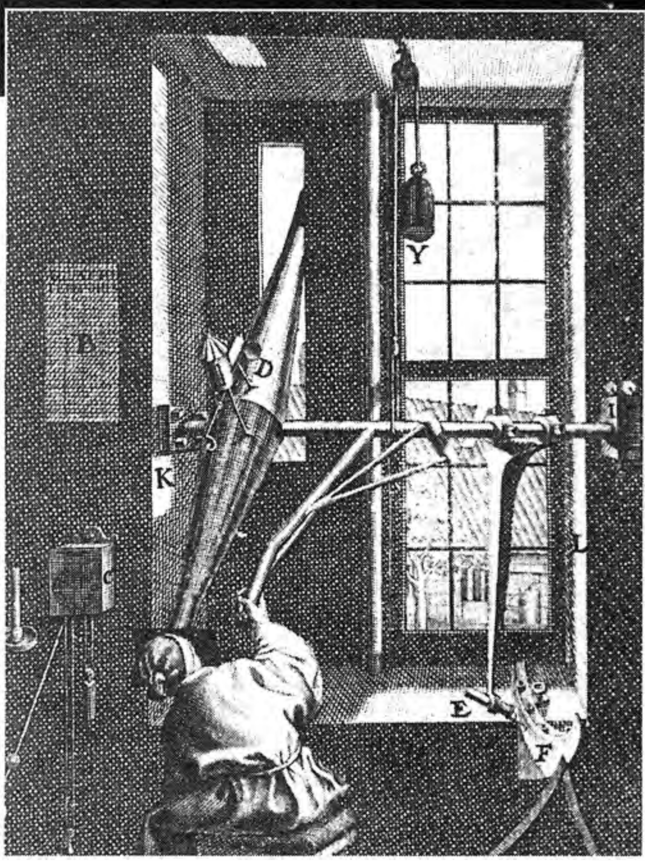
Dino de Paoli, based in Hannover, Germany, has written widely on the history of science. This article is an expanded form of presentations given at the universities of Milan and Paris in February 1997, sponsored by the Schiller Institute.



Spaceless-Timeless Boundaries in Leibniz

by Lyndon H. LaRouche, Jr.

The Platonic notion of a self-bounded domain is the center of work founding modern experimental physics, and the central feature of economist LaRouche's own work on the subjects of cognition, evolution, and the physical-economic notion of "anti-entropy."

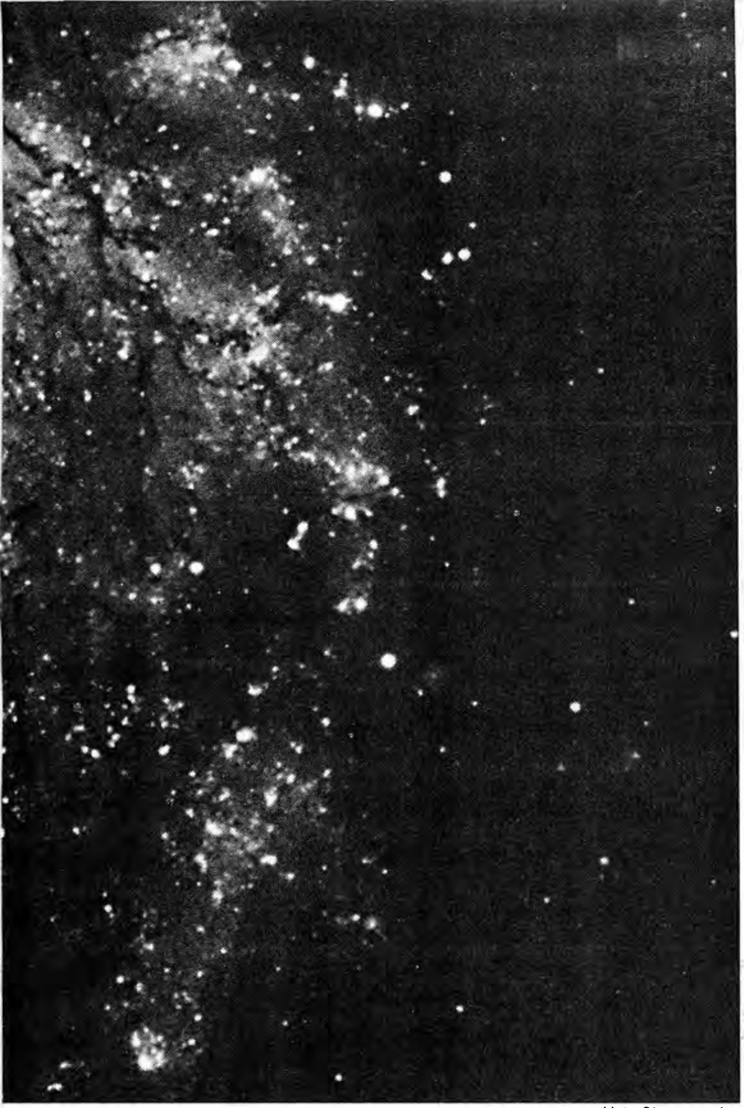


Danish astronomer Ole Roemer (1644-1710) and one of his astronomical instruments, the Machina Domestica *(House Instrument). Roemer, who collaborated with both Leibniz and Huygens, discovered the finite velocity of light, determining its value to a remarkable degree of accuracy.*

Dino de Paoli had invited my comment on those areas of his article in which he made direct, or implied reference to my work on the subject of evolution.[1] Examining his manuscript, I found only one point which would benefit, in a relevant fashion, from the addition of my amplification. That point is, the Platonic concept of a self-bounded domain, as this occupies the center of the systematic thought of Plato, Nicholas of Cusa, Kepler, Leibniz, and Riemann, and is at the center of my own discoveries in the field of physical economy.

I think that the parade of ideas represented by de Paoli's manuscript, is, by itself, fully adequate for the specific line of argument he develops there. Therefore, I concluded that the appropriate place for my added points of emphasis, would be an epilogue to his work.

As de Paoli touches repeatedly upon this point in his paper, the first known notion of a self-bounded domain, appears in the work of Plato.[2] After Plato, that conception finds a central position in writings of St. Augustine, is the center of work founding modern experimental physics, Nicholas of Cusa's *De*



Hale Observatories

docta ignorantia, is the kernel of Johannes Kepler's method for determining the solar orbits, and, is the heart of the method of Gottfried Leibniz.[3] It is the central feature of Bernhard Riemann's revolutionary, 1854 habilitation dissertation, and spills over, from there, into Albert Einstein's notion of relativity. It is the central feature of all those portions of my own work, in which I address the subjects of cognition, evolution, and the physical-economic notion of "anti-entropy."

This conception of the bounded domain, acquired its most rigorous expression in Plato's later writings. This leading feature of all those dialogues, appears by way of the central ontological paradox—the *One-Many* paradox—introduced in his *Parmenides.*[4] That dialogue was a central point of reference for Gottfried Leibniz. It is the point of departure for addressing the subject of self-bounded domains, here.

1. Boundedness: The Case of Simple Hypothesis

Given, a series of transformations in sundry kinds of objects, which is more real, the individual objects of that series, or the underlying process of transformation which orders the changes involved? What is the *One* underlying principle of change, which, in this way, subsumes the *Many* elements within that series? De Paoli's paper makes repeated references to the appearance of this Platonic conception in the work of Leibniz.

The solution to that *Parmenides* paradox is the indispensable precondition for comprehension of any intrinsically non-linear process, such as distinguishing, functionally, between living and non-living processes, and between the mental processes of men and monkeys. On this account, the implications of the *Parmenides* paradox occupy a central position in all of my references to the scientific principles on which competent economic studies depend absolutely. Since 1952, my most frequent references to this Platonic principle, have been keyed to the form in which that is presented in Bernhard Riemann's 1854 habilitation dissertation, the paper which founded the first true non-Euclidean geometry.[5] For the purposes implicit in de Paoli's paper, the best choice of my recent treatments of this matter, is my "The Essential Role of 'Time-Reversal' in Mathematical Economics."[6]

That much said as a matter of required introduction, we now proceed to construct the relevant argument underlying the notion of self-bounded domains.

In any rational system of thought, such as the geometry of Euclid, Socratic method shows, that the possibility of consistency among those propositions which we treat as theorems, depends upon a discoverable set of axiomatic assumptions, such as adducible definitions, axioms, and postulates. The Classical term identifying such a set, is "hypothesis." The set of definitions, axioms, and postulates associated with a Euclidean geometry, is to be recognized as a case of *simple hypothesis.*

The collection of theorems associated with such underlying assumptions, is usefully described as a "theorem-lattice." Once such a simple hypothesis, such as a Euclidean one, is adopted, the standard which a proposition must meet, to qualify as a member of that lattice, is that it must not contradict the existence of any among the set of definitions, axioms, and postulates of the relevant hypothesis.

That theorem-lattice, so bounded, and subsumed, by its hypothesis, constitutes *a simply bounded domain.* If the hypothesis itself could be included within that array, the result would represent a self-bounded domain. For reasons which de Paoli references in his published work on the relevant discoveries of Georg Cantor and Kurt Gödel, no formal, deductive-inductive

1. Dino de Paoli, "Was Darwin an Evolutionist, or Just a Social Reformer?," *21st Century Science & Technology*, Fall 1997, p. 26.
2. Most notably, in his *Timaeus*.
3. As de Paoli references this: Gottfried Leibniz, "Correspondence with Arnauld," in *Gottfried Wilhelm Leibniz: Philosophical Papers and Letters* ed. by Leroy E. Loemker (Dordrecht: Kluwer Academic Publishers, 1989) [hereinafter referenced as "Loemker"], pp. 331-350.
4. Between the ages of 12 and 18 years, I engaged in an intensive course of study, in chronological order, of the most celebrated 17th and 18th centuries' philosophers of England, France, and Germany, from Francis Bacon through Immanuel Kant. By mid-course, I had become a follower of Leibniz; I occupied the last two of those years both studying Immanuel Kant's *Critique of Pure Reason* (in English translation), and refuting its implicit attacks upon the standpoint of Leibniz. It was from study of Leibniz that I learned the method of Plato; moreover, everything subsequently learned in this matter, assures me that Leibniz's view of Plato is the correct one, and contrary readings in error. From that standpoint, the *Republic* is indispensable for grounding one's approach to the later works. On the authority of principles of certainty which I define in these pages, these later works of Plato, I know, with certainty, address the implications of the ontological paradox posed in the *Parmenides*.
5. Bernhard Riemann, *Über die Hypothesen, welche der Geometrie zu Grunde liegen* ("On the Hypotheses Which Underlie Geometry"), in *Bernhard Riemanns Gesammalte Mathematische Werke*, ed. by H. Weber (New York: Dover Publications reprint, 1953), pp. 272-287.
6. *Executive Intelligence Review*, Oct. 11, 1996, Vol. 23, No. 41). [Also, in *Fidelio*, Winter 1996 (Vol. V, No. 4)].

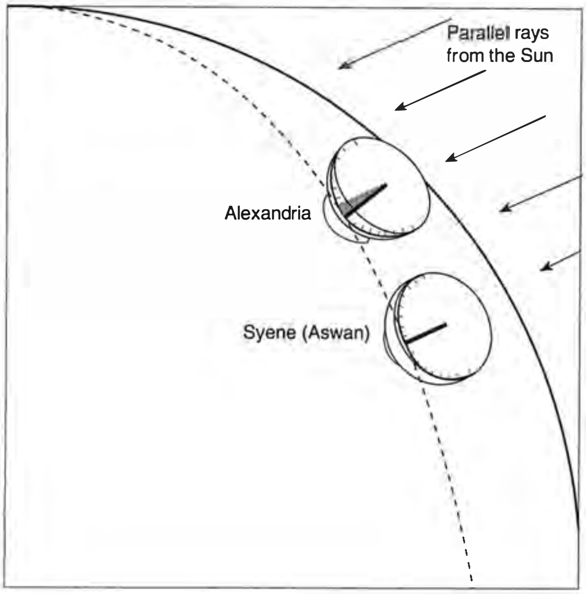


Figure 1
ERATOSTHENES' METHOD OF MEASURING THE EARTH

In the third century B.C., the scientist Eratosthenes measured the shadow cast by the Sun, on identical sundials at the Egyptian cities of Alexandria and Syene, about 490 miles directly south of Alexandria. The gnomon of each sundial was perpendicular to the Earth, and the measurements were taken at noon on the day of the summer solstice. There was no shadow at Syene, but a shadow of 7.2° at Alexandria.

From this anomaly, Eratosthenes knew that the Earth had to be a spheroid—2,300 years before anyone had actually seen the evidence from space. Knowing the distance between the two cities, he was also able to calculate the Earth's circumference to be about 24,500 miles. The significance of Eratosthenes' experiment is not the remarkable accuracy with which he was able to compute the circumference of the Earth, but his demonstration that knowledge is not based on experience, but on investigating the paradoxes in our experience.

Eratosthenes' discovery contains the germ of the essential principles common to all valid, fundamental experimental discoveries of universal physical principles.

system, such as a Euclidean geometry, could satisfy the requirements of a self-bounded domain.[7] Nonetheless, the relations between the theorem-lattice and hypothesis, even as they appear in a deductive-inductive domain, are worth examining, as a preparatory step toward comprehension of actually self-bounded domains.

Anyone who recalls the experience of a "pre-New-Math" education in Classical Euclidean geometry, could reflect on the fact, that the pedagogically efficient chain of lesson-plans ordering the theorems of that curriculum, form a sequence. Extension through any orderable sequence, connotes the functional notion of relative time. The working point here, is that, although the theorems may be thus orderable in relative time, the hypothesis which underlies the generation of those theorems, does not change from the first to last element of that pedagogical sequence: The hypothesis has the quality of *relative timelessness;* that hypothesis exists *simultaneously* in all times and places which might be occupied by the occurrence of any present or future theorem of the corresponding theorem-lattice. Thus, because of this consideration (simultaneity), and, also, of the notion of hypothesis as "efficiently underlying" the whole existence of the theorem-lattice, the *relatively timeless* hypothesis "bounds" the entirety of the virtual space-time domain coincident with that lattice.

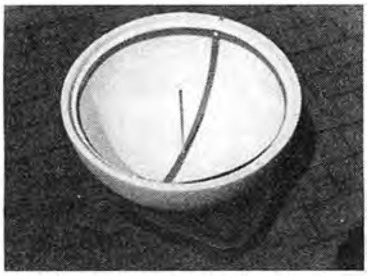
I imagine the commonplace expression in today's U.S.A., would be: "Switch channels for just a moment." De Paoli referenced, repeatedly, passages in Leibniz's writings in which Leibniz was expressing an application of Plato's *Parmenides* conception; and, sometimes, also, the Classical Christian conception of God as dwelling within His universe (not outside it). However, God dwells not within the confines ("bounds") of time and space, but, rather, exists pervasively in "the universal simultaneity of eternity" of His entire Creation. That is the kind of conception toward which we are working our way, step by step, here. The "relative timelessness" of even simple Socratic hypothesis, already contains the germ of the conception which Leibniz knew as "simultaneity of eternity."[8]

Now, that said, back to where we left off before this interpolation. Move ahead, from the case of simple hypothesis, to higher hypothesis. Focus upon the case of Bernhard Riemann's revolutionary discovery: a generalized notion of *physical geometry.*

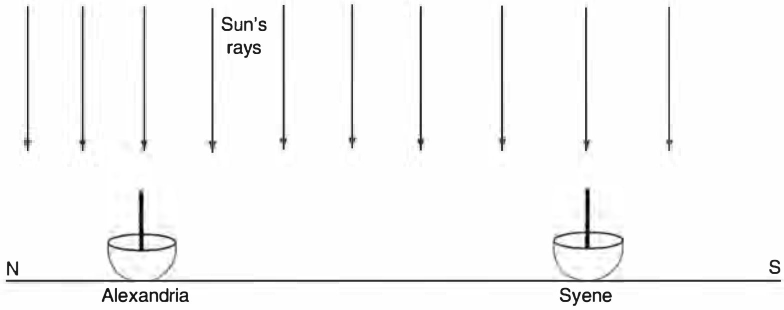
2. How the Human Mind Actually Functions: Higher Hypothesis

Imagine that you are the most celebrated fellow-scientist among Archimedes' contemporaries and colleagues, the mathematician Eratosthenes, from Plato's Academy at Athens. Eratosthenes was, during the time of his correspondence with Archimedes, the leading scientific mind of Egypt. Among Eratosthenes' numerous other revolutionary discoveries of universal principle, he conducted an experiment which not only proved that the Earth was approximately spherical—not flat—but also gave him a remarkably good estimate for the size of the Earth.[9] In fact, this discovery in the field of geodesy, during the third century B.C., made possible the construction, about 17 centuries later, of the world map drawn by Nicholas of Cusa's associate Paolo Toscanelli. The latter was the same map which Columbus used to plan his first, 1492, voyage of discovery to the Caribbean.[10] The specific importance of that discovery by Eratosthenes, for our purposes here, is that it contains within it the germ of the essential principles common to all valid fundamental, experimental discoveries of universal physical principles. That is the principle, as developed by Carl F. Gauss, upon which Riemann based his revolution in physics; we reference that experiment here to illustrate Riemann's principle.

"Is the Earth flat?" That is to say, if a plumb-bob on a string points downward, could we construct, at a level below any part of the Earth's water-level surface, a plane which would always intersect, at right angles, all of the lines extended from all plumb-bobs? If so, then, we could also construct a plane just sufficiently above any local region of the Earth's ground/water



Hemispheric sundial, built for replication of Eratosthenes' experiment.



A flat Earth?

Figure 2
WHAT DID ERATOSTHENES HAVE TO KNOW?

At first glance, Eratosthenes' experiment seems simple to replicate: Find a partner about 500 miles north or south of you, and measure the shadow of the Sun at a predetermined time on the same day. But, if you put yourself in Eratosthenes' shoes, you see how much thinking about geometry and celestial mechanics are involved in this experiment.

For example, to determine the time of the summer solstice, requires much observation, over years. And once you determine that the daylight hours are longest on the solstice, there is the question of why this is the case. What is the relationship of the Earth to the Sun? What is the relationship of angle and circular measure? Why can you assume that the Sun's rays are parallel when they hit the Earth? If the Earth were flat, would there be any shadow at Alexandria? How do shadows on a sundial change over the course of a day?

surface, that it would always be at approximately right angles with all plumb-bob lines, and yet never more than merely touch the surface of earth or waters, tangentially, in that locality. Choose a region along the Nile from Aswan to Alexandria. Select the direction of this line to correspond to an astrophysically determined south-north direction. Define noon, as the instant the shadow cast by an upright pin (as aligned by a plumb-bob) lies along that south-north line. Now, as the Sun appears to move from east to west, consider the area swept by the shadow of the pin upon a surface which always lies at a right angle to the plumb-bob lines. This shadow will define the relevant sector of a circle. The plane of that sector, then, defines the supposed "flat Earth."

Measure the distance from Aswan to Alexandria along the south-north line.

Construct a number of virtually identical, hemispherical sundials. Place a straight pin (*gnomon*), whose upward orientation is to be supplied by a plumb-bob, at the South Pole of each such hemisphere (pointing along a plumb-bob line, downward). Mark the interior of each of the hemispheres similarly, to measure the angle of the shadow cast by the pin. Place these sundials at measured intervals along the south-north line between Aswan and Alexandria. Consider the point in time at which the shadow of the pin is cast in the northerly direction, to be defined by the experiment, as the same time at which the same effect is seen in each of the other deployed sundials: simultaneity. (See Figure 1.)

Kenneth Murray/Photo Researchers

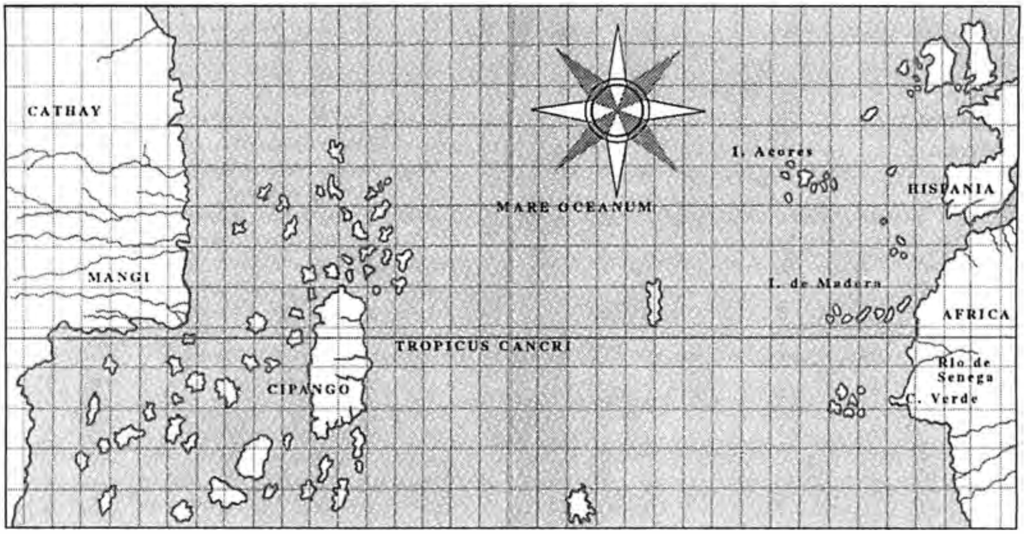
A 1734 sundial in an astronomical observatory built by Jai Singh in Rajasthan.

Now, compare the marked angles defined, simultaneously, by the shadows of the pins of each and all of the sundials. The angles are different; the difference is ordered, south-north, by a consistent difference of "more than" that shadow cast by the preceding sundial. If the Sun were a large object, located at a great distance from a presumed "flat" Earth, the angles ought to appear no worse than very nearly equal, according to the proposition expressed by the design of the experiment. Express copies of each and all among these angles, as sectors of a circle. Shade-in the sector of that circle defined as the difference between the smallest and largest of these angles. Note the length of the arc of the circle defined by that shaded area of difference. Now, that latter arc corresponds to the idea of the

7. I knew Leibniz's notion (and, therefore, Plato's) of "simultaneity of eternity" as a self-bounded domain, from my adolescent studies. A new line of approach, the one represented here, was opened up for me by an early 1952 review of my then ongoing discoveries in physical economy from the standpoint of first, Georg Cantor's notion of the transfinite, and, then, later that same year, a rereading of Riemann's habilitation dissertation from the vantage-point in physical economy which Cantor had assisted me in achieving.
8. *Cf.* de Paoli, "Was Darwin an Evolutionist?," Part 2, *passim.*
9. "XVIII. Eratosthenes," in *Greek Mathematics,* trans. by Ivor Thomas, "Loeb Classical Library" (London: William Heinemann Ltd., 1980), pp. 260-273.
10. Ricardo Olvera, "Columbus and Toscanelli," *Fidelio,* Spring 1992.

distance between the relatively most southerly, and relatively most northerly placements of the sundials.

By the principle of similar figures, the Earth is shown to be a spheroid, and the length of the approximate Great Circle, defined by the experiment's south-north direction, can be estimated by treating the arc in question as an arc of that Great Circle. Eratosthenes' estimate for the polar diameter of a spheroid-Earth, was off by a margin of about 50 miles.[11]



An adaptation of Paolo Toscanelli's 1480 map. The geodesic work of Eratosthenes during the third century B.C. made possible the construction, about 17 centuries later, of this world map, which was used by Christopher Columbus to plan his first, 1492, voyage of discovery to the Caribbean.

The purpose of supplying this description, here, is to demonstrate, that in the scientific method developed by Plato, and also such among his collaborators as Theaetetus and Eudoxus, there is contained the germ of the same principle upon which Nicholas of Cusa based the launching of the modern experimental physics of his followers Leonardo da Vinci, Johannes Kepler, Gottfried Leibniz, *et al.;* the same principle at the foundation of Carl Gauss's discoveries in astrophysics, geodesy, and geomagnetism; the same principle of experimental physics expressed by Gauss's development of the theory of curved surfaces out of his work on biquadratic residues, all this the work of Gauss upon which Bernhard Riemann premised the discovery of the first true non-Euclidean (for example, physical) geometry.[12]

Look again at Eratosthenes' experiment, from this modern vantage-point.

As we indicated, the design of the experiment conformed to testing the "flat Earth" assumption. In other words, an assumption that the subject of the experiment lay within a two-dimensional phase-space. The evidence showed a deviation from simply linear extension, requiring the introduction of a third dimension, a three-dimensional phase-space. As Nicholas of Cusa showed the transcendental nature of *pi* (π), in demonstrating that the sides of a many-sided regular polygon could never coincide with the circumference of the circle inscribing it,[13] the fact that the Earth's surface is curved, not flat, shows that at every smallest *infinitesimal interval* along any attempted linear extension of the tangent to that surface, the two dimensions of the tangential plane are rendered discontinuous (that is, "non-linear") by the causally efficient, "bending" presence of the third dimension. This feature of Eratosthenes' experiment, becomes crucial in that work leading through Gauss's contributions into Riemann's employment of Leibniz's principle of *Analysis Situs,* to generate the discovery of the first true, "non-linear," physical geometry.

Andrew Spannaus

Nicholas of Cusa's associate, Paolo Toscanelli, designed this measuring gauge for his gnomon, inlaid in the floor of the Cathedral of Santa Maria del Fiore in Florence. The upper part of the instrument, placed 90 meters above, in the lantern of the cathedral cupola, projects an image of the Sun. The two circles and the thin lines to the right are brass inlaid in marble. The small circle was used by Toscanelli himself. The Latin inscription, written in 1510 after Toscanelli's death, reads, "1510, First Day of the Ides of June," the day of summer solstice in the calendar at that time.

11. Thomas, *op. cit.* Readers should attempt to replicate this simple experiment with means corresponding to those available in third-century B.C. Egypt; thus, they would learn respect for the degree of precision achieved by Eratosthenes, and in Columbus's map of the world, the one drawn by the Paolo Toscanelli, who also instructed Columbus on some relevant points, in their correspondence.
12. B. Riemann, on his specific debts to Carl Gauss for the sources of his own revolutionary discovery, *op. cit.*, pages 273 (biquadratic residues) and 276 (curved surfaces). The prime Gauss references are (originally): On biquadratic residues, the famous, variously translated *Theoria residuorum biquadraticorum* [first treatise, 1-23, 1828; second treatise, 24-76, 1831-32]; on curved surfaces, the "Copenhagen prize essay" of 1822, and the variously translated *Disquisitiones generales circa superficies curvas* of 1828: *Carl Friedrich Gauss Werke* (Hildesheim-New York: Georg Olms Verlag, 1981), Vols. I, II, IV. German translations of the two parts of the paper on biquadratic residues are found, in *Untersuchung über Höhere Arithmetik von Carl Friedrich Gauss,* ed. by H. Maser (New York: Chelsea Publishing Company, 1981), pp. 511-586.
13. *De docta ignorantia* (1441). See, Lyndon H. LaRouche, Jr., "On The Subject of Metaphor," *Fidelio,* Fall 1992.

Now, focus sharply upon the question: "What is the kernel of this experimental method?" That kernel is, that all validatable discoveries of a new physical principle, are each derived as the generation of original conceptions which resolve an experimental paradox of the following general specifications.

In each case, as in the referenced case of Eratosthenes' experiment, we approach the experimental subject-matter burdened with the freight of our pre-established opinion: at best, with a well-grounded hypothesis, as we have defined the notion of simple hypothesis above. However, we have added something else. In the first type of instance, we confront our pre-established mind-set with a fact which is as believable, by its nature, and by the same methods of observation which we have employed to support our pre-existing hypothesis. We are able to show, and that in a fashion to which our pre-established beliefs could not object, that the disturbing fact has the same kind of experimental authority as we have supposed our pre-established hypothesis had had up to this time. However, the efficient existence of the new fact introduced, can not be accepted as a valid theorem of the pre-established hypothesis. Thus, these two, equally validated sets of facts, can not co-exist in the virtual universe which we had believed we inhabited. A true paradox.

Plato's *Parmenides* is exemplary. Do the terms of the series exist? "Without doubt." Does the difference among the terms of the series exist? "Also, without doubt." Do these two kinds of facts inhabit the same universe? "It can not be denied." Then, the commonality of the terms of the series, is the adducible commonality of their differences? "Yes" (perhaps, one hears a tone of reluctance). Then, that commonality exists? Silence: paradox. Then, that commonality subsumes the co-existence of the terms and their differences? Stunned silence: Once again, by means of ontological paradox, we are compelled to cross over from the virtual reality of mathematical formalism, into Riemann's "domain of physics," science.[14]

Confronted with such paradoxes, successful original discoverers have generated ideas which prove to be solutions. If we are able to validate these ideas experimentally, we call these ideas "new physical principles." The problem is, that although we are able to prove the existence of the discovered principle by experimental methods, we can not represent explicitly, in mathematics, or in any other medium of communication, the mental processes, entirely within the individual mind, by means of which such valid ideas are generated. This process of discovery, entirely within the sovereign recesses of the individual discoverer's cognitive processes, can not be degraded for representation, into a form of analysis which could be *explicitly* represented within the bounds of words or mathematical procedures.

We can represent the object, the discovery, produced, as it may be explicitly presented as an experimentally validated solution for the explicitly stated relevant paradox; but, we can not satisfy the demands of the smelly street-beggars of formal logic and sense-certainty, to produce a representation of cognition which is agreeable to their prejudices. The fact that these ideas can not be explicitly represented in such ways, misleads such misguided persons, who are sometimes known as empiricists, positivists, or sophists, into arguing, that this difficulty signifies something defective in this class of ideas. "Perhaps," they argue, "these kinds of ideas are only airy, mystical fantasies."

Such critics behave very foolishly. Unlike the empiricists, really intelligent people *know* these kinds of ideas far better, with far greater scientific certainty than anyone could know sense-impressions as such. The proof of that latter fact, is readily demonstrated to intelligent, competently educated schoolchildren. This statement is to be recognized as representing a paradox about paradoxes and their solutions.

This extraordinarily relevant, and most important paradox, must be restated here, once more. That act of discovery, which proves experimentally to have been a valid, original discovery of a new physical principle, occurs entirely within the sovereign domain of the individual person's cognitive processes. The production of such ideas could never be analyzed in the way a manufacturing design is analyzed into the form of a division of assembly-line labor in a manufacturing firm. The sophist might be tempted to interject: "See, you admit that you do not know what was going on in the mind of the person who made that discovery!" False! Some among us do know.

"All validatable discoveries of a new physical principle, are each derived as the generation of original conceptions which resolve an experimental paradox. . . ."

Really intelligent people, do know. How do we know this? We can repeat the discovery within our own sovereign cognitive processes; intelligent primary- and secondary-school pupils do this often. This is what is commonly called "a good education." In a good educational program, the pupils are aided in reliving the act of each among a series of those original discoveries of principle, the which have been passed down to us from persons who often lived centuries, or even millennia earlier.

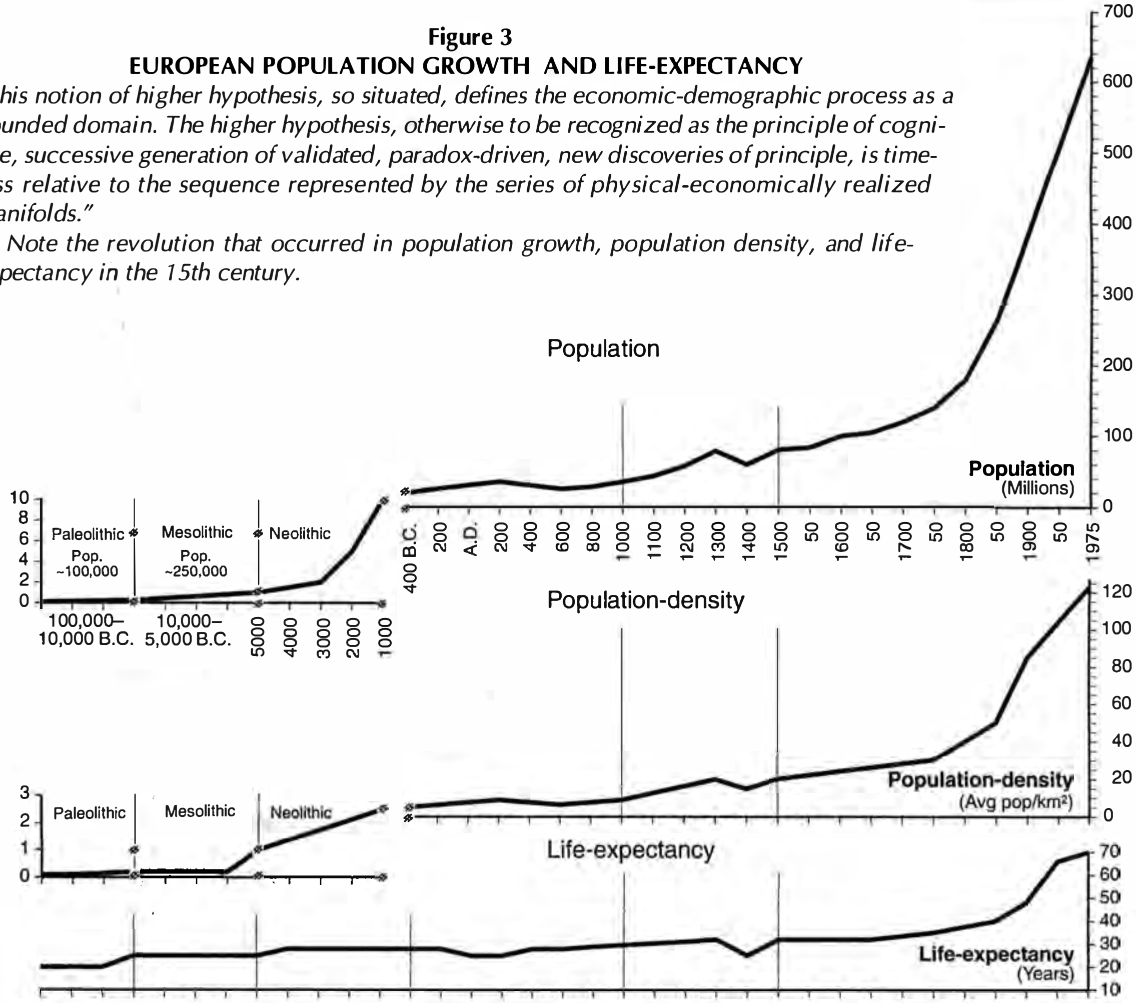
"How?" We confront the pupil with the facts of the paradox which confronted that discoverer. We structure the curriculum to bring each such challenge to the pupil, at the point in the curriculum that that student has accumulated the prerequisites for tackling the problem. We structure the social situation, to foster a positively catalytic, relevant quality of Socratic interaction among the members of the class (teacher and pupils). We do not "tell" the pupils the answer, until they, or, at least, some among them, have made the relevant breakthrough. We, then, assist the pupils in discovering how the discovery may be experimentally validated. We, then, walk the class, as a whole, through the Socratic process of re-examining each step of the preceding process, from paradox

14. Naturally, we are referencing the types of series in which the differences are not of a simply mathematical form, in which the essential feature of the ordering of the difference includes a *qualitative* feature, as Riemann echoes Leibniz in his crucial observation (*op. cit.*, p. 285-286): *Wenn aber eine solche Unabhängigkeit der Körper vom Ort nicht stattfindet, so kann man aus den Massverhältnissen im Grossen nicht auf die im Unendlichkleinen schliessen; . . . . Es führt dies hinüber in das Gebiet einer andern Wissenschaft, in das Gebiet der Physik, welches wohl die Natur der heutigen Veranlassung [Mathematik—LHL] nicht zu betreten erlaubt.* This was already Leibniz's argument, a century and a half earlier, as de Paoli stresses the relevant issue in Part 2 of his paper, under "The Continuity of Forms: *Similarity*." The fact, that we must depart mathematics for physics, as Riemann demands, does not mean we are helpless to discover efficient notions of functional ordering which are different from customary mathematical ones, but no less rigorous, and, indeed, far more powerful. We turn to a crucial aspect of that in the two concluding sections of this epilogue.

Figure 3
EUROPEAN POPULATION GROWTH AND LIFE-EXPECTANCY

"This notion of higher hypothesis, so situated, defines the economic-demographic process as a bounded domain. The higher hypothesis, otherwise to be recognized as the principle of cognitive, successive generation of validated, paradox-driven, new discoveries of principle, is timeless relative to the sequence represented by the series of physical-economically realized manifolds."

Note the revolution that occurred in population growth, population density, and life-expectancy in the 15th century.



through to experimental validation.

In an educational process of that sort, the subject being taught is "the experimental scientific method." Yes, we are also fostering the pupil's reenactment of particular discoveries of principle, in his or her own mind. Those are the individual *terms* of a process of education, but not the educational process itself. Our familiar friend, the ontological paradox of Plato's *Parmenides,* has, once again, put in its appearance. The individual topics addressed in the successive lesson-plans, are the *individual terms* of the sequence of education, the *Many.* The corresponding *One,* the real subject of the course considered as a whole, is the Socratic method for generating valid new discoveries of principle. That One is the educational process, within which these Many are making their functionally ordered appearance, manifesting the differences among all of them, each in turn.[15]

If we are successful, we are invoking two classes of conceptions within each individual student.

First, on the relatively lower level, the student is being enabled to watch the cognitive processes which are in play, during the successful generation of a new idea which solves an ontological paradox of the type indicated here. Although we can not look directly, by means of our senses, into the sovereign cognitive processes of another person's mind, that person has the potential ability to look into his, or her *own* cognitive processes.

The success of this attempt, to know oneself, as Socrates prescribes, depends, more or less absolutely, upon a second class of conceptions. This second class focusses upon the social process within which individuals' cognitive processes of discovery are situated.

Teacher: "How did Johnny discover the solution? Jimmy, do you wish to take a stab at it?"

Jimmy: (Smiling proudly) "Sure. He had to be thinking the same thing I was thinking. . . ."

Johnny, at that point, may be thinking, that if Jimmy can look into Johnny's mind, perhaps, Johnny, by thinking about that, can see into his own mind. In other words, if Johnny can construct a kind of clone-image of Jimmy, within his own, sovereign domain of cognition, that "clone-Jimmy" would be situated to watch Johnny's cognitive processes at work. In that

15. "Function," in this instance, is subsumed by the notion of *Analysis Situs,* rather than "algebraic function."

	Life Expectancy (years)	Population density (per km²)	World population (millions)
Gorilla		1/km²	.07
Chimpanzee		3-4/km²	1+
MAN			
Australopithecines B.C. 4,000,000-1,000,000	14-15	1/10 km²	.07-1
Homo Erectus B.C. 900,000-400,000	14-15		1.7
Paleolithic B.C. 100,000-15,000	18-20+	1/10 km²	
Mesolithic B.C. 15,000-5000	20-27		4
Neolithic B.C. 10,000-3,000	25	1/km²	
Bronze Age B.C. 3,000-1,000	28		50
Iron Age B.C.1,000-	28		50
Mediterranean B.C. 500-A.D. 500	25-28	15+/km²	100-190
A.D. 800-1300 Europe	30+	20+/km²	220-360
17th Century Europe	32-36		545
18th Century Europe	34-38	30+/km²	720
19th Century United Kingdom	43	90+/km²	1,200
1970			3,900
United States	71	26/km²	
West Germany	70	248/km²	
Japan	73	297/km²	
China	59	180/km²	
India	48	183/km²	

DEVELOPMENT OF HUMAN POPULATION

way, Johnny could be looking over clone-Jimmy's cognitive shoulder, at Johnny's own cognitive-processes-at-work. That is the "secret" of the Socratic method's superiority to any other mode of thinking. The essential function of the schoolroom class, is to produce that optimistic quality of Socratic interaction among the pupils, the which is the most likely method for producing the relatively maximum ration of such geniuses.

We can not look directly into the cognitive processes of other persons. There is no "objective" method, through the senses, or through a medium of language, to see directly the cognitive processes operating within the mind of another person. Nor, for that matter, has any scientist ever seen directly the domain of nuclear microphysics. However, we have three "objective facts" respecting any validated discovery of new physical principle (for example), by aid of which we can know how the mind of another person, even one long deceased, produced that validated idea. These three facts are: the paradox, which demanded the solution; the reflection, in the form of an instruction, of the discovered idea, which represents the discovered solution for that paradox; and, the experimental validation of the efficient existence of the discovered idea of the new physical principle. *If* any among us has replicated the generation of that solution from our own cognitive processes' successful replication of the original discoverer's attack upon the paradox, that internal cognitive experience by each among us, represents shared, validated knowledge of the generated idea.

"Look at your mind, Jimmy. What is the real reason you said that? Look behind what you were thinking, then. Was there some assumption, which caused you to choose that answer?" The same principle, by means of which a class of pupils may find the excitement of being able to "see directly" into their own and other pupils' minds, by aid of the kind of social interaction just described, is the key to the Socratic method of looking at one's own sovereign processes of cognition, in an efficiently critical way.

On that account, the opening two paragraphs of Riemann's habilitation dissertation, are the most important part of that entire work: they state the paradox which the dissertation, in its entirety, is deployed to solve.

There, first, Riemann instructs us to recognize (as Leibniz had already warned us of this), that the whole business of a mathematics derived from using Euclid's geometry as a basis for algebra, is flawed, from the outset, with incurably mystical, and, in fact, false presumptions. Second, that, up to that time, the most famous mathematicians and philosophers, from Euclid through the great A.-M. Legendre, had failed to pierce this veil of darkness.[16] Third, that Riemann himself will proceed, after those two paragraphs, to lift that veil, inch by inch, and, so, present a new conception of mathematics, from the standpoint of experimental physics.

In the Platonic way of thinking which Riemann's discovery expresses, as did Leibniz before him, the idea of space and time as Kantian absolutes, is banned from science. Each of the two is reduced from the aprioristic rank of mathematical royalty, to that of just another participating, colligating citizen, like mass, of the *n*-dimensional republic of experimental physics.

As is adequately elaborated in sources such as my above-cited paper,[17] in Riemannian "non-Euclidean," or "physical" geometry, every permitted extensible dimension of that geometry, is derived from an experimentally validated discovery of universal principle. Paradigmatically, we associate this notion, of a physical, or non-Euclidean geometry, with so-called "physical principles." However, since the efficient existence of mankind, and the sovereign cognitive processes of discovery of principle itself, are integral features of a self-bounded universal domain, this universe—we must, as de Paoli has emphasized the necessity for this, and as Riemann also recognized this,[18] include the discovered characteristics of cognition itself as "principles of nature."

So, Riemann strips the idea of "space" and "time," as supposed geometric dimensions, of their claims to *a priori* existence within geometry. Aprioristic presumption is to be replaced, entirely, by relativistic notions of space and time, each

16. Of course, Gottfried Leibniz had made that specific argument, repeatedly, more than a century before Riemann. However, it was politically unsafe for any candidate for habilitation to present openly any explicit or implied praise for the reputation of Leibniz, or to omit ritual praise for Isaac Newton, in the Hannover still ruled by the British royal family, where Göttingen University was located. The published output of Carl Gauss, as that of his protégé Bernhard Riemann, is the product of faithful students of Leibniz, who held Newton's work in that contempt which certain of Riemann's posthumously published writings state most cogently. However, for the same British political reasons which impelled Gauss to refuse to publicize his own discovery of non-Euclidean geometry, Riemann, in his habilitation dissertation, not only suppressed acknowledgement of Leibniz's work, but supplied ritual passing praise for the Newton whose scientific claims Riemann held in contempt.
17. "The Essential Role of 'Time-Reversal' in Mathematical Economics," *op. cit.*
18. *Riemanns Werke, op. cit.*, pp. 509-538.

of these premised upon nothing other, and nothing more than, the experimental standard of proof for physical principles. The false, incompetent, contemplative view, which is proposed by an Aristotle and Averroes, as by the materialists, the empiricists, the positivists, and the existentialists generally, is prohibited from future intrusions upon the domain of scientific Reason.

At this point, the science of physical economy takes over.

The empirical foundation of physical economy, is the progress of mankind, as expressed in a positive correlation between increased potential relative population-density, and improvement of demographic characteristics of the households of that population taken in its entirety.[19] (See Figure 3 and table.) The outstanding, and indispensable feature of such progress, is scientific and technological progress; however, the principles of Classical artistic culture have indispensable bearing upon the ability of a population to assimilate, and to generate the benefits of scientific and technological progress. For our immediate purposes, let it be understood that what we say respecting scientific progress is merely exemplary of the combined effect of advances in knowledge in both physical science and in Classical art-forms. The science of physical economy is rooted in the study of the reciprocal relationship between advances in knowledge of principle effected through the cognitive processes of the individual mind, and how the ordering of the practice of the same society fosters, or injures, the reproduction and further improvements in power of those sovereign cognitive processes within the individual members of society.

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LaRouche's contributions to the science of physical economy are built on the work of Gottfried Leibniz (left) and Bernhard Riemann (right).

The correlation and connection between the two facets of that cognitive process, its inputs and outputs, so to speak, and the increase of "anti-entropy" of the physical-economic process, is the proper center of attention, in efforts to define relevant notions of functional relationship between mankind and the universe at large.

We now examine, summarily, the minimal relevant essentials of that science.

The general principle which I have employed, since late 1952, to represent the impulse of scientific and technological progress, is the notion, that the number of dimensions of a Riemannian manifold is (implicitly) the number of validated discoveries of principle cumulatively represented by the relevant human practice. Each new, validated discovery of principle, thus, effects a transformation denoted by the ordering, n to $n + 1$. That taken into account, we have the following.

My first general contribution to advancement of Leibniz's science of physical economy, was the notion of "anti-entropy" as expressed by physical economy itself. Expressed in descriptive terms, we have the following. Let the amount of physical-economic investment *per capita,* required to maintain equipotential of the demographically expressed *potential relative population-density* of the economic process, be regarded as the *per capita* "energy of the system." Let physical-economic output in excess of required "energy of the system," be regarded as "free energy." Then, under the condition that the *per capita* physical-economic costs of the *per capita* "energy of the system" increase as a function of technological progress, the ratio of "free energy" to "energy of the system" must not decline, and must, preferably increase through technology-driven, capital-intensive, power-intensive modes of increase of the productive powers of labor. This expresses "anti-entropy" of the productive process as such.

My second general contribution, involves the use of the mathematical notion of "cardinality" to express the quality of transformation which occurs through increasing the implicitly denumerable density of mathematical discontinuities *per* arbitrarily chosen interval of action. This, I correlate with the increase of a Riemannian manifold, from one of "n dimensions," to a higher order of "$n + 1$ dimensions." This is another way of expressing the dimensionality of the manifold.

Thus, the increase in "cardinality," so defined, represented by a succession of scientific and technological advances of the form $n \rightarrow n + 1$, is an anti-entropic impulse. The realization of that impulse, in the mode of capital-intensive, power-intensive progress, generates that increase of the ratio of "free energy" to "energy of the system," the which expresses the anti-entropic, physical-economic determination of an increase of the potential relative population-density of the society.

Thus, the impulse of scientific and technological progress corresponds to an ascending series of manifolds, n, $n + 1$, $n + 2$, ... Since each such manifold is bounded by an hypothesis, the which is absolutely inconsistent with the hypotheses corresponding to all other manifolds of the series, we have a new form of the *Parmenides* paradox, in which the individual terms are simple hypotheses of the Riemannian-mani-

19. E.g., LaRouche, *op. cit., passim.*

fold form. The difference among these manifolds (hypotheses) defines a subsuming hypothesis, corresponding to Plato's notion of "higher hypothesis." This "higher hypothesis" expresses that principle of cognition, through which the relevant, validated new discoveries of principle have been generated.

That, in essence, is the kernel of the LaRouche-Riemann Method, so called, because it is the application of Riemann's discoveries to the problems of measurement posed by my own definitions of both physical-economic anti-entropy, and of cognition.

This notion of higher hypothesis, so situated, defines the economic-demographic process as a bounded domain. The higher hypothesis, otherwise to be recognized as the principle of cognitive, successive generation of validated, paradox-driven, new discoveries of principle, is timeless relative to the sequence represented by the series of physical-economically realized manifolds.

The *Parmenides* type of paradox so posed, is resolved by the discovery of this higher hypothesis through the processes of cognition. This discovery represents simply a higher order of the same kind of discovery realized as validated simple hypothesis.

This higher hypothesis is itself subject to improvement. Think of a series of higher hypotheses, as a representation of the process of improvement. Name that series "hypothesizing the higher hypothesis." The latter is only a higher order of the principle of discovery associated with the generation of an higher hypothesis.

Each of these higher hypotheses is relatively timeless—relative to the series of terms which it subsumes.

The experimental validation of hypothesizing such higher hypotheses, defines, implicitly, a generalized notion of the relationship between man and the universe. The positive correlation of increase of mankind's potential relative population-density, with improvement of the demographic characteristics of all of the society's households, defines the relevant experimental relationship between mankind and the universe, and, thus, between the cognitive processes of the individual person in the society and that same universe.

Essentially, the experimental validation of the internal hierarchy of higher hypothesis, in this way, implicitly defines the universe as a self-bounded domain, pre-designed to bend to mankind's will when man's demands conform to valid higher hypothesizing. This is man's only possible access to knowledge of the lawful ordering of our universe. This is the sole basis for what is termed "natural law." This is science.

3. 'Time-Reversal': *What is Reason?*

There are two distinctions in behavior which separate the human species from all animal species. One of these, which we have just addressed, is the creative power of the adequately developed, sovereign cognitive processes of the individual: the process, by means of which, validated discoveries of new physical principles are generated by original discoverers, and that generation replicated by students. The second is the *Prometheus-principle,* the capacity to use foreknowledge of the future consequences of changes in behavioral hypothesis, as a guide to selecting the changes in hypothesis to be adopted presently.

Since any orderable series of hypotheses is subject to an higher hypothesis, and since that higher hypothesis is relatively timeless, in respect to the hypotheses it subsumes (bounds), it is the principle of higher hypothesis which enables man to effect a "reversal of time," such that the future efficiently determines the present.

This combination of the creative, sovereign power of the individual cognitive processes, and the efficient role of "time-reversal" within cognition, constitutes *Reason.*

The connection between the principle of hypothesis and the principle of time-reversal, is adequately represented in the recent paper of mine which I have already noted for reference here.[20] Therefore, I limit exposition here to two illustrations. First, a summary illustration of the role of "time-reversal" in the management of a well-run modern industrial firm. Second, a comment upon de Paoli's contrast of the roles of special relativity and general relativity in the work of Albert Einstein.

First, a few relevant, prefatory remarks, situating my selection of the case of a capital-intensive industrial enterprise.

As a result of a process of willful deconstruction of the U.S. economy (among others), which has been ongoing since approximately 1966, the percentile of the U.S. labor-force employed as operatives in production of goods, has collapsed catastrophically. Whereas, at the close of World War II, over 60 percent of the labor-force was so engaged, today, it has fallen to about one-fifth. Worse, even among those surviving operatives, the levels of skill and cognitive development are vastly inferior to the qualities prevalent during the 1946-1966 interval. This is aggravated by an imminently catastrophic spiral of collapse in quality of education and cultural development of the personality, at all educational levels, throughout almost the entirety of post-war generations.[21]

Still worse. Thirty years ago, the overwhelming majority of U.S. adults, whether associated with industry as administration, engineers, or operatives, took pride in the contributions of production to our standard of living and national economic security. The frontiers of technological progress, in the domains of tool-making, and research-and-development, were the popularly sought, elite qualities of employment, and employee satisfaction, in our productive sectors. Today, under the ideological deconstruction brought about through the influence of such "post-industrial" utopianisms as "consumerism," perhaps a majority of our population views the producers as "greedy, irresponsible" adversaries of the consumer. Under such conditions, even mere sanity in popular thinking about our economy, let alone what has become the relatively alpine quality of actual competence, is not to be taken for granted.

In these times, that endangered species, the technologically advancing, capital-intensive, power-intensive mode of industrial production, is almost the last bastion of sanity in the U.S. economy's daily life. The relevant, persisting, distinguishing feature of such a firm, now, as in lost, happier economic times, is that such a firm is the best choice of microcosmic reflection

20. Op. cit.

21. If present trend-rates continue, we are not far distant from the state of affairs, in which the following hypothetical incident might become commonplace. A pollster, employed in going from door-to-door, reports that when he asked the respondents whether or not they were in favor of democracy, the overwhelming majority replied, "Yes." However, when he asked those same persons, if they have voted in the preceding general election, more than 50 percent replied with the question, "What is voting?"

Philip Ulanowsky/EIRNS

"In a good educational program, the pupils are aided in reliving the act of each among a series of those original discoveries of principle, the which have been passed down to us from persons who often lived centuries, or even millennia earlier." Here, Dr. Robert Moon, a nuclear physicist who worked on the Manhattan Project, works with children to replicate Ampère's electrodynamic experiments.

of the processes at work in the national and world economies as entireties. Here, the combined forces of capital-intensity and matching pressures of technological attrition, find their relatively most concentrated expression.

In sum, each present moment of life of such an industrial firm, is, in itself, a microcosm of its situation in the vast economic process in development in the world at large. Immediately, that moment assumes the form of the expression of the past in the present moment's production, but, also the expression of the future development which the gains from present production must be directed to fostering. The productive process is using up physical capital invested years earlier, consuming materials and components which went into supplier firms' production months, even years earlier. At the same moment of today's produced output, there is ongoing work in preparing those capital purchases, those product designs, and so on, which will not be seen in production for months, years, or even longer, yet to come.

The most characteristic feature of that ongoing process, is change. Technological change, and also other kinds of change. Many of these changes involve modifications of the hypothesis governing production, product-design, and marketing. Forecasting—foreknowledge—is the essence of effective management: a veritably Promethean quality of foreknowledge, is the aura surrounding the great industrial managers of the modern economic history of the pre-1966 United States, and of Germany's industrial development since 1876.[22]

The illustration from science as such, is provided in the form of a comment on a paragraph from de Paoli's manuscript:

> Einstein once wrote that his first major discovery (Special Relativity), was stimulated by the need to solve a given anomaly present in Newtonian physics. But, he added, there was no visible anomaly which pushed him to his second major discovery (General Relativity). He arrived at it after he had decided to see where the limit of the first discovery lay: where the first theory, as any theory, would break down. *A society, in a sense, has the same moral imperative to search for truth. To be able not simply to react to, but to anticipate catastrophes one must know in advance* [emphasis added].

De Paoli's argument here, should be restated for emphasis. He argues, that whereas Einstein's work on Special Relativity was provoked by an *existing* experimental paradox, the work on General Relativity was provoked by foreknowledge of a *future* paradox which would challenge the validity of Special Relativity.

22. See Anton Chaitkin, "Leibniz, Gauss Shaped America's Success," *Executive Intelligence Review*, Feb. 9, 1996, pp. 22-57. See also "How Henry Carey and the American Nationalists Built the Modern World," *The New Federalist*, June 2, 1997, an edited transcription of Chaitkin's May 10, 1997 presentation to an FDR-PAC Policy Forum. The complete FDR-PAC Policy Forum, which also includes Lyndon H. LaRouche, Jr.'s "The Significance of FDR for Today," is available on videotape from FDR Political Action Committee, P.O. Box 6157, Leesburg, VA 20178 (No. FDP 97-011, 180 minutes).

Focus upon the antepenultimate sentence in that quoted paragraph. How should we read "limit" in that sentence? Let us substitute the term "boundary," as we have developed it here. Restate the sentence, to reflect that substitution: ". . . to discover where the boundary of the first discovery lay." That substitution implicitly removes any reader's defensible attribution of mystification to that paragraph.

The "boundary," of course, lies within that which bounds an hypothesis, the relevant higher hypothesis, the latter relatively timeless with respect to the series of hypotheses which it bounds. To restate the point accordingly: Once we have been guided to a validated hypothesis under the guidance of an higher hypothesis, the principle of change embedded within the latter suggests the successor term of the series. The relative timelessness of higher hypothesis is thus, once again, seen at its work.

Thus, when Einstein, like his relevant contemporary, Hermann Minkowski, was impelled this way, by considerations of non-Euclidean geometry, Einstein's mind was directed toward reflection upon the precedents supplied by Kepler, Leibniz, and Riemann. In other words, toward adoption of a new higher hypothesis, the higher hypothesis of relativistic physical geometry. This, even in that form, already reflects the general nature of true foreknowledge within the setting of individual human cognition.

Recall the elegant excerpt from Minkowski's famous lecture on the subject of Einstein's formulation of so-called "Special Relativity": that, henceforth, time, by itself, and space, by itself, must vanish, to be superseded by physical space-time. Minkowski did not fully grasp the implications of what he himself had uttered in that lecture. He had not fully escaped from the grip of the "politically correct" classroom ideology of those times, "linearization in the extremely small."[23] Nor, did Einstein's commentator Hermann Weyl escape the "politically correct" grip of this same fallacy.[24] Einstein's movement away from the positivism of Ernst Mach, to which he had been conditioned, toward Riemann's, Leibniz's, and Kepler's standpoint in method, constituted at least a fair approximation of a new choice of higher hypothesis. In this way, Einstein confronted himself with the issues of whether the universe within which Special Relativity might lie, were bounded, or not.

In short, in his approach toward General Relativity, Einstein acted out of foreknowledge of a future devastating paradox, which would confront Special Relativity in the same manner Special Relativity itself had been generated as a solution for a devastating ontological paradox incurred by the then "politically correct" Newton-Cauchy-Clausius-Maxwell ideological mind-set.

The universe which de Paoli identified by Leibniz's term *Immensum,* is bounded, but not quite in the sense Einstein argued the point. Nonetheless, the issue of bounding was sufficient to prompt Einstein to think of the requirements this issue itself required be addressed.

Here, respecting the illustrative point at hand, relativity, the issue is not that Einstein's approach contained some error. The point here, is, that every good scientific discoverer is guided to a validatable new hypothesis—e.g., new physical principle—under the influence of a set of assumptions corresponding to what we have identified as an higher hypothesis. An higher hypothesis in any expressed approximation, such as the Einstein case indicates, implicitly begets one or more successor hypotheses to any initial hypothesis so generated.

As modern, capital-intensive industrial production provides us one illustration, the case of a science-driver "crash program" of task-oriented research and development, provides the second illustration.

Return to that classroom where bright students Johnny and Jimmy were sharing reflections on the feasibility of insight into the sovereign domain of one another's, creative, cognitive processes. Let time pass, such that all of the members of that illustrative classroom-case, are now participating in a great "crash program" science-driver teamwork, such as the U.S. Manhattan Project, or the German-American space program under the (relevant) brilliant logistics veteran of Lt.-General George S. Patton's U.S. Third Army, General (J. Bruce) Medaris, and, later, the John F. Kennedy Manned Moon-landing imperative. The first thing which Johnny and Jimmy ought to have known, by no later than the time they entered this crash program, is a few historical facts about modern "crash" varieties of science-driver programs; this knowledge would help them keep their intellectual moorings amid the sometimes storm-tossed internal life of the kind of program they are entering.

The first approximation of "crash" science-driver programs, was the 15th-century Golden Renaissance, inclusive of the work of Filippo Brunelleschi and of Nicolas of Cusa's followers through Leonardo da Vinci. The next notable example, is the late-17th-century science-economy mobilization, under France's Minister Jean-Baptiste Colbert. The third outstanding example, was launched in France, beginning 1792-1794, under the direction of Lazare Carnot and, his collaborator, and former teacher, Gaspard Monge. The next science-driver program was that directed by Prussia's Alexander von Humboldt, who, in collaboration with Carl Gauss, established Germany's 19th-century world supremacy in physical science. The next,

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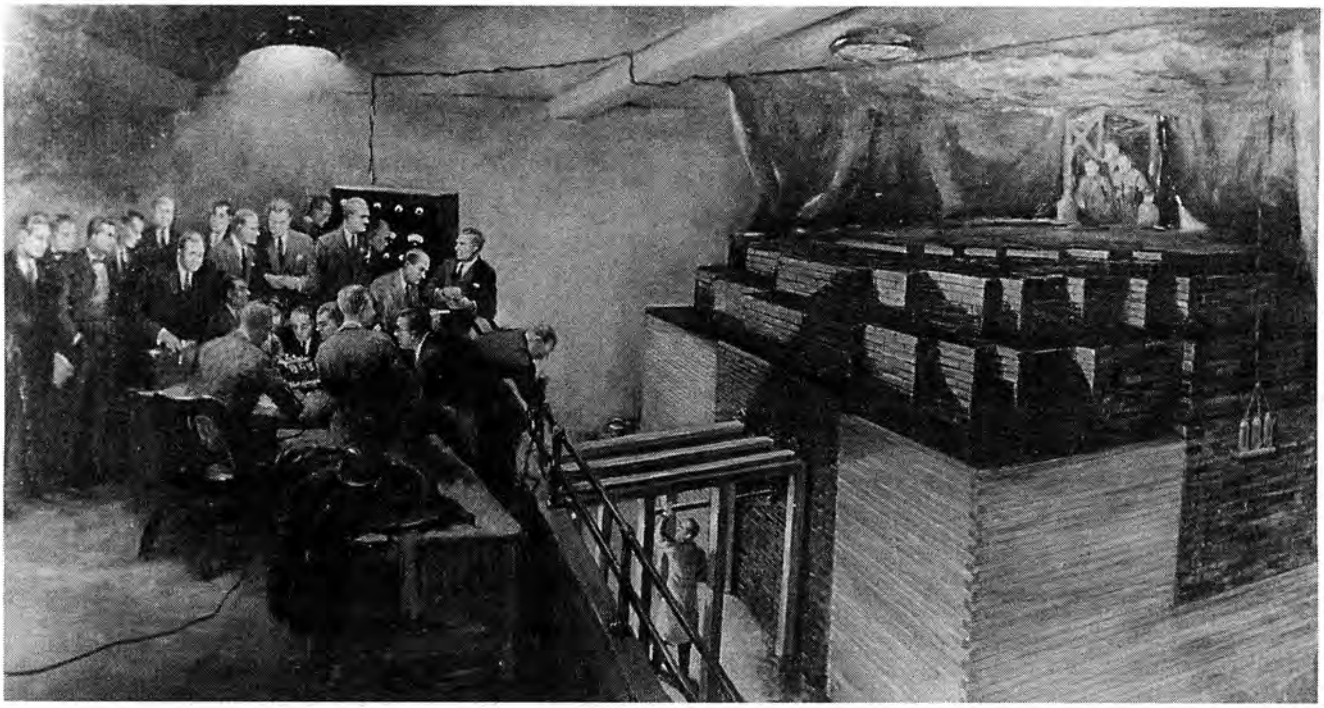
23. E.g., *Raum und Zeit* (1907). There are usefully provocative implications in Russian mathematician Minkowski's scientifically flawed adherence to the cause of a compatriot, Nicolai Ivanovich Lobachevski. The mathematical formalist's shortfall in Minkowski's argument, was the subject of a paper by Dr. Johnathan Tennenbaum, "A Topological Shock-Wave Model of the Generation of Elementary Particles," *Executive Intelligence Review*, Feb. 1, 1983. On Gauss's view of Lobachevski's *Geometrische Untersuchungen zur Theorie der Parallellinien* ["*Geometrical Investigations on the Theory of Parallels*"] (Berlin: 1840), see a relevant remark by Carl Gauss to H.C. Schuhmacher, in concluding paragraph of a letter of Nov. 28, 1846: *Carl Friedrich Gauss-H.C. Schuhmacher Briefwechsel*, III (Hildesheim-New York: Georg Olms Verlag, 1975), pp. 246-247. This is the location in which Gauss dated his own discovery of a non-Euclidean geometry to 1792, a relevant claim which is borne out by close examination of the plan of action subsuming Gauss's *Disquisitiones arithmeticae* considered in entirety. Compare with Lobachevski's last published (1855) views on this subject, *Pangeometrie* (1858), which had first appeared in Russia about the time of Gauss's death. Provocative, but ultimately a fatal shortfall, is Lobachevski's use of spherical action, a less general consideration than Riemann's [see footnote 12, above] "*Wenn aber eine solche Unabhängigkeit der Körper vom Ort nicht stattfindet, so kann man aus den Massverhältnissen im Grossen* nicht *auf die unendlichkleinen schliessen.* . . . As Leibniz warned, any such use of simply curved metric, implies the same ontological error against which we are warning here. Lobachevski, like Minkowski after him, was unwilling to make the final, crucial break with mathematical formalism, thus to enter, wholeheartedly, the domain of experimental physics.
24. Hermann Weyl, *Raum, Zeit, Materie* (1918), and expanded English edition *Space, Time, Matter* (1922) (4th ed.) (New York: Dover Publications [reprint], 1950). See, again, footnote 12, on the issue of this fallacy.



Chicago Historical Society

"When we pack together, so to speak, a large number of gifted and highly motivated professionals, together with the technicans who assist them, we have created a forcing-chamber for the relatively highest rates of scientific progress." Here, a painting by Gary Sheahan, depicting the scene, on Dec. 2, 1942, when, with key Manhattan Project scientists present, the first nuclear reactor achieved a self-sustaining chain reaction.

world-shaking "crash science-driver" leap in economy, was unleashed under the U.S. Presidency of Abraham Lincoln, which established the U.S. economy as the world's most powerful nation-state economy, and the most technologically advanced, during a period of approximately two decades.[25] The sixth "crash program," modelled directly on the U.S. precedent, was the late 19th-century hitching of Germany's world leadership in science, to the development of a united Germany's economy-driver, the expansion of its machine-tool-design sector.[26]

The U.S. Manhattan Project and the Germany-U.S.A. aerospace "crash programs," can not be competently understood, in any economic-functional sense, until we view them as outgrowths of a modern tradition which features prominently the earlier case-histories to which I just referred. So, situate our Johnny and Jimmy, in the anteroom awaiting induction into a new "crash program."

Nothing stimulates the creative scientific capabilities of the unblocked professional as much as a social environment in which he, or she, is prodded to replicate virtually daily, floods of original discoveries, both old ones he, or she, had not worked through earlier, but also a constant outpouring of new proposed solutions to both well-known and previously unsuspected ontological paradoxes. This is the environment for which the suitable, earlier classroom experience of our Johnny and Jimmy prepared their minds. From that classroom, Johnny and Jimmy learned many particular things; but, as we stressed here earlier, the important thing, above all else, which they came to know, was the principle of a Classical-humanist form of educational process. It is their youthful attunement to that process, which will make them valuable recruits to the program they are now entering.

Thus, when we pack together, so to speak, a large number of gifted and highly motivated professionals, together with the technicians who assist them, we have created a forcing-chamber for the relatively highest rates of scientific progress. This, on the condition that some unifying sense of purpose supplies a red thread of coherence to a complex array of diverse, relatively more short-term, often ad hoc objectives.

The connection of such science-drivers to the economy, is essentially the following.

There is an essential, underlying equivalence between the perfection of the design of a proof-of-principle laboratory experiment, and the principle underlying a corresponding, entirely new family of machine-tool designs. It is the perfected design of a proven, proof-of-principle laboratory experiment, which supplies the model of reference from which a corresponding, new set of machine-tool designs is derived. Such a machine-tool-design principle, then assumes the role of an hypothesis in generating a fertile theorem-lattice of beneficial applications.

Perhaps the most dramatic demonstration of this connection, is the unpleasant fact, that, during the present century, no leading nation of modern European civilization has generated an actual, net physical-economic profit, except under the impact of large-scale military mobilizations, either in preparation for, or conduct of what is termed modern "annihilation war-

25. Anton Chaitkin, *op. cit.*
26. *Ibid.*

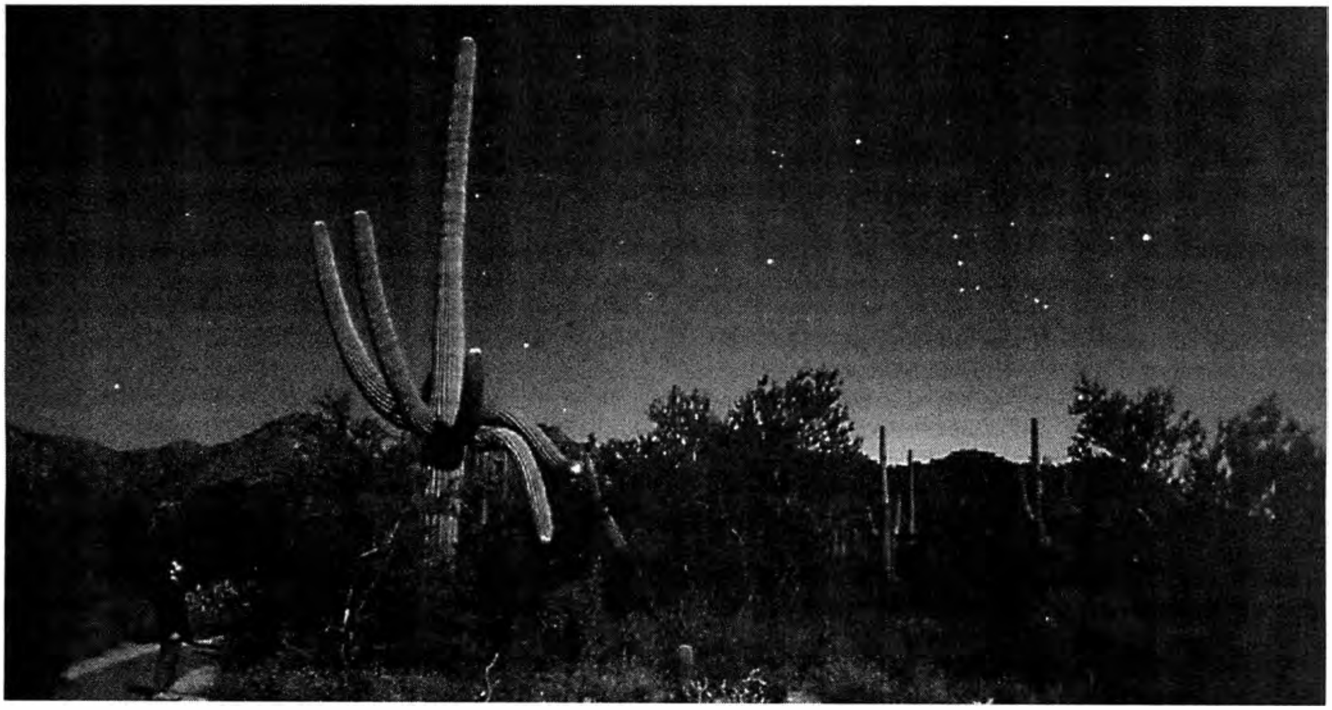
fare."[27] The vast economic waste, which military expenditure represents, is certainly not the source of this net physical-economic profitability. It is, rather, the spill-over of frontier technologies, from science, into the machine-tool-design sector, under conditions of forced-draft economic growth for national security, which is the source of profitability. In these cases, the spill-over from the military into the civilian economy, results in an exceptionally high rate of improvements in design of products and of productive processes. The Germany-U.S. "crash" space-program, had a famously similar benefit for the U.S. economy as a whole.

This in no way is an argument for war. Rather, it is a demonstration of the fact, that, since the assassination of U.S. President William McKinley, only under war-time or related conditions of national urgency, are the economically depressive, parasitical habits of Wall Street and similar carpet-baggers, held in check. If we could rid ourselves of the tyranny of those monetarist and kindred parasites (and their Federal Reserve System), who were the constituency for Presidents such as Teddy Roosevelt and Calvin Coolidge, the people of the U.S. would never have experienced anything inconsistent with general and soaring economic prosperity, throughout the past century as a whole.

27. This is a definition exemplified by the notions of Alfred Graf von Schlieffen's *Cannae: The Principle of the Flank*, and also his design of the so-called "Schlieffen Plan." "Annihilation" does not signify exterminating some large number of people, military personnel and/or others, but, rather, annihilating the adversary's capacity needed to continue organized warfare, as the Confederacy was destroyed by the combination of Sherman's "hammering" right flanking attack and Grant's bloody "anvil."

The points to be listed here, in summation of these illustrations, are these. First, the source of progress in both the potential relative population-density and demographic characteristics of family life, is that which Christianity identifies as the nature of each individual person, as made in the image of God. That nature is expressed by that facet of cognition, which efficiently links the individual personality to the "simultaneity of eternity," those cognitive processes by means of which mankind hypothesizes the higher hypothesis. Second, establishing forms of social relations which are appropriate to forcing the relatively highest rates of generation, and replication, of discoveries of both physical and Classical-artistic principles, produces an individual type which represents the relatively highest degree of development of the moral character of the individual person, while it also ensures the relatively highest rates of generation and efficient assimilation of scientific, technological, and artistic-cultural progress.

Whether Einstein's General Relativity survives, or not, the nature of Einstein's motivation in that matter, as de Paoli represents this, is the key which unlocks the treasure of cognition, and presents the greatest ration of its benefits to mankind generally. Rather than responding only to the goads of present failure, as when a devastating ontological paradox forces itself upon us, it were better to act out of a conscience governed by foreknowledge, including foreknowledge of those issues of principle which will foreseeably oblige us to abandon what we often cuddle as "our traditional culture." Prevent the disastrous consequences of sins of omission now, before they become the ruinous sins of commission which bring our civilization down.



Frank Zullo/Photo Researchers

"It was through the astrophysical methods of constructing solar-sidereal calendars, that man developed those methods of astrophysical investigation, the which were then applied to develop, first, macrophysical science, and, next, supply, from astrophysics, the methods of necessary and sufficient inference upon which a competent microphysics relies." Here, the constellation Orion in a moonlit sky.

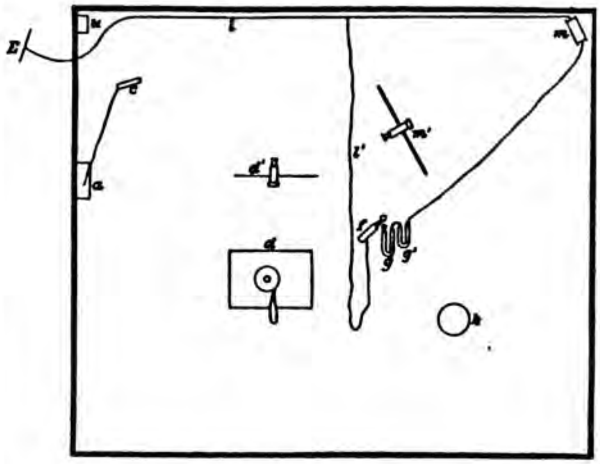


Figure 4
EXPERIMENTAL DETERMINATION OF THE ELECTRODYNAMIC CONSTANT BY KOHLRAUSCH AND WEBER

Bernhard Riemann participated in the 1854 experimental determination of the electrodynamic constant (c) at Göttingen University. His habilitation thesis of the same year, On the Hypotheses Which Underlie Geometry, *reflects on the deeper considerations of geometry and physical measure embedded in such experimental work. This schematic, from R. Kohlrausch and W. Weber's 1857 report of the experiment, diagrams the static electric discharge and measuring devices used to determine the ratio of the mechanical to the electrodynamic measure of electricity.*

Contrary to popular science accounts, Riemann had recognized the significance of the relationship of their physical constant to the velocity of light in 1854, years before Maxwell proposed his problematic interpretation.

Source: R. Kohlrausch and W. Weber, "Elektrodynamische Maassbestimmungen insbesondere Zurückführung der Stromintensitäts-Messungen auf mechanisches Maass," Leipzig, 1857.

4. Generalized *Analysis Situs:* Simultaneity of Eternity

The standpoint of Leibniz's *Analysis Situs* obliges us to reorganize the presently popular notion of science according to the implications of a nine-cell matrix. We must divide the empirical evidence of science among three types of processes, and the evidence bearing on all processes among three well-defined categories. The notions of the three types, we derive from a careful scrutiny of the traditional distinctions among non-living, living, and cognitive processes. The three categories of evidence, are astrophysical, microphysical, and macrophysical.

The relations among the nine cells so established, are ordered as follows.

The three types are distinguished by their respective differences in internal ordering. The division between living and non-living processes, for example, is implicit in the moment of transition from a living (anti-entropic) to a dead (entropic) ordering of biological organization. The difference among living processes, is between cognitive and non-cognitive processes (as the anti-entropic ordering of cognitive processes has been distinguished so here).

The distinction among types of evidence, pertains to the effect of the inhering limitations of the human sense-apparatus, respecting the observation of ordering-relations among phenomena. For example: How did a culture, living, for several thousand years in Central Asia, during a time the Vernal Equinox was in the constellation of Orion, construct an approximately 26,000-year equinoctial cycle? It was through the astrophysical methods of constructing solar-sidereal calendars, that man developed those methods of astrophysical investigation, the which were then applied to develop, first, macrophysical science, and, next, supply, from astrophysics, the methods of necessary and sufficient inference upon which a competent microphysics relies.[28]

Once the requirement for *a generalized Analysis Situs* is recognized, the currently popularized views on scientific specializations must be subordinated, by placing the primary emphasis upon efforts to master the nature of the combined interrelations among the nine cells defined by the just-described types and categories of evidence. Each of all possible permutations of the nine cells, corresponds to an actually existing experimental subject-area of generalized *Analysis Situs.* Science is then primarily located in that hypothesizing of the higher hypothesis which subsumes each and all of these permutations under a commitment to satisfy the requirements (sooner or later) of a single conception of universal ordering-principle.

The experimental basis for such a generalized *Analysis Situs,* is located within the domain of the science of physical economy: mankind's essential existential interrelationship within the universe as, in every possible sense, an entirety. That is to say, the experimental basis for a competent general notion, which distinguishes between what is, and what is not to be considered "science," lies in the evidence of that "Great Experiment," the which is mankind's total relationship to the universe as a whole. The subject of science is mankind's willful relationship between the ordering of transformations within the universe, as correlated with both the increase of human potential relative population-density in the universe (relative to the Earth's surface), and the improvement of the demographic characteristics of households in the human population taken in its entirety.

These scientific ideas must incorporate the efficient role of "time reversal." "Time reversal" is to be understood, not merely as foreknowledge in its simplest expression; the possibility of the efficiency of such foreknowledge within this universe, must be taken into account as showing us the necessary functional character of the lawful ordering of the physical universe. That man could exist, to command the universe to increase our species' potential relative population-density, with accompanying improvement of the demographic characteristics of households, signifies that the willful

28. One of the best demonstrations of this point, is the history of the Ampère-Weber discovery of the implications of the macrophysical angular force of electrodynamics for understanding of the ordering of electrodynamic relations within microphysical relations on the scales of atomic and nuclear physics. See Laurence Hecht, "The Significance of the 1845 Gauss-Weber Correspondence," *21st Century Science & Technology*, Fall 1996, p. 21.

aspect of man's efficient relationship to the universe, is an integral potential embedded in the adducible design of the laws of the universe.

Once we situate science thus, there is no law of universal entropy in this universe. The universe submits to mankind, only when man's command is intrinsically anti-entropic. The law of the universe, in the only way we could know its law, is the law of universal anti-entropy. The principle of anti-entropy, so situated, is the fundamental principle of science.

To grasp the more deeply underlying implications of this, extend the successful self-development of this "Great Experiment" forward and backward in time, without straining toward the non-existent "infinity" which hesychastic fools seek to touch. The boundaries of existence of the universe, are not to be found in some distant past, some distant future, or, far, far away. Man's mind locates the actual boundary, as Nicholas of Cusa did, in that which bounds hypothesizing the higher hypothesis, which is Plato's notion of the Good, Plato's notion of an efficient agency located within no lesser domain than the simultaneity of eternity.

If we but extend the process of hypothesizing the higher hypothesis respecting the relations internally characteristic of this universe, that hypothesizing represents a series of higher hypotheses. That sequence is time. If we treat this "time" as any other dimensionality of a Riemannian universe, as Riemann's discovery demands that we treat time so, then the ontological unity of time defines the series representing the Manyness of the universe as a whole as a One, which Plato named the Good, and defines that One as the relatively timeless, efficient existence, inhabiting and ruling the simultaneity of eternity. The necessary existence, within the domain, of the Good, as that existence is shown by the characteristics of the domain itself, is that which bounds the domain, and defines it as a self-bounded domain. God created this universe, and bounds it, but, always and forever, from the inside. This, as Leibniz rightly insisted, is the best of all possible worlds.

There are no "yardsticks," of any kind, existing outside this universe, this self-bounded domain whose limits are the simultaneity of eternity. There exists no external place, from which an observer might contemplate the universe; there is no *deus ex machina*. The universe can be known only from the inside. The test of such latter knowledge, is securing the proof of the existence of the would-be observer as an efficient actor occupying a necessary place within the universe which is to be observed. That is to emphasize, that the first question the would-be observer must address, is the question whether the observer himself exists, the question which Rene Descartes so flagrantly flunked.

We know we exist within the universe, when we begin to change that universe for the better, when we begin to realize the inborn, special potential of the human individual, the cognition whose power to make miracles fascinated our Johnny and Jimmy. Somewhere, in the higher reaches of hypothesizing the higher hypothesis, mankind is known to exist as the kind of special creature whose innermost nature, whose outermost efficiency, Johnny and Jimmy were exploring in the classroom. Man exists because man is needed. The nature of this need is obvious; man is deployed, as the agency assigned to change this universe, from within: to improve it, and, in the process, to improve the moral character of the individual person, as Johnny's and Jimmy's moral character was being improved by the characteristics of the kind of good, Classical-humanist education they were enjoying in that classroom.

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

AN APPENDED REMARK
Eratosthenes' Estimate for the Spheroid

In my description of Eratosthenes' measurement of the curvature of the astrophysically determined south-north distance from Syene (Aswan) to Alexandria, I chose to omit from that discussion of the matter, a collateral fact, which Eratosthenes must, necessarily, have taken into account, but which was not explicitly addressed in the putatively original accounts of that experiment available to me (see page 48).

It is a point whose crucial implications are made clear, more than 1,800 years after Eratosthenes, by the revolutionary achievements of Johannes Kepler and Carl Gauss in astrophysics. This bears upon a point which I did address, later, in reference to this point as it arose to be a central feature of Bernhard Riemann's habilitation dissertation.

Factually, the omitted point is deceptively simple. In this case, as is not uncommon in the history of science, once we challenge ourselves to determine whether a simple fact is also a mathematically-physically elementary one, as in the case of the development of what I referenced, on page 60 [footnote 28], as the Ampère-Weber proof of the existence of an "angular force" in electrodynamics, we find ourselves confronted by proof that the relevant, elementary principle of science, is usually expressed in deceptively simple, often overlooked appearances.

In the text of the manuscript, I recounted the placement of sundials along a measured (walked), south-north distance, in Egypt, from Syene (the ancient site of Aswan), to Alexandria. I pointed to the difference in angles of the noonday shadows of the gnomons, at the extremities of that measured distance. I pointed to the arc defined by the difference between those two angles, as corresponding to the distance from Syene to Alexandria. In my paper, I skipped an intermediate step: did Eratosthenes merely assume that that arc was a spherical one, or had he taken some precaution which gave him persuasive evidence that the arc was situated in a spherical geometry, or nearly so?

I assumed that he had; thus, with good conscience, I was able to keep my account of the experiment limited to the barest principles underlying the proof of curvature itself. In this present location, I do a bit more, than merely supply the defense of my editorial assumption on this simple point. To aid the reader in discovering my deeper purpose here, I provide the design of an illustrative figure. [SEE Figure 5] In this figure, I close in upon a finer detail of the actual Eratosthenes experiment. Having placed that figure on the implied blackboard, I describe what I have drawn, as follows.

Let the curved line $S \rightarrow A$ represent the measured south-north line from ancient Syene to Alexandria. We have Eratosthenes' hemispherical sundials placed at point S, and point A. We also have similar sundials placed at measured (walked) intervals, P_1, P_2, P_3, . . . , between S and A, along line $S \rightarrow A$. Now, by construction, we may compare the angles, q_S, q_1, q_2, . . ., q_A, corresponding to the pre-measured arcs of the series $|S-P_1|$, $|P_1-P_2|$, $|P_2-P_3|$, |. . . |.

Also, by construction, we may compare the measured lengths of those arcs. We may, similarly, compare the ratios among those measured arc-intervals (into which arc $S \rightarrow A$ is divided by the placing of these sundials), to the ratios of the *differences* in the angles subtending those arc-intervals. In short, the construction of the experiment, shows that Eratosthenes *designed the experiment* in such an axiomatic way, as to provide for a simply geometrical determination of the relative degree of self-similar *constancy* of the rate of curvature along line $S \rightarrow A$.

In my experience of the manifest behavior of the human mind, design of experiment expresses intent, whether that intent is witting, or not. Thus, we know, by study of the structure (design) of Leonhard Euler's argument, that in his defense of what was expressed later, as Augustin Cauchy's castration of the calculus, by a "limit theorem," that Euler was not merely mistaken, but intentionally so. The fact, that a mind as sophisticated in formal mathematics as he was, could present as proof, a theorem axiomatically pre-embedded in his design of the supposed proof, is clear showing of his intent to commit a fraud. Thus, the internal evidence of his own argument, shows that he perpetrated a fraud. This is the fraud, which, notably, was continued after him, as in the tradition subsuming Lagrange, Laplace, Cauchy, Grassmann, Clausius, Lord Kelvin, Maxwell, Hermite, Lindemann, Felix Klein, Bertrand Russell, Norbert Wiener, and John Von Neumann, as also Theodor von Karman's Anglolphiliac revision of the work of Bernhard Riemann and Ludwig Prandtl in hydrodynamics.

On the basis of that evidence internal to that micro-design of Euler's hoax, we are, thereafter, not merely justified, but obliged, to take into account Euler's political situation, as a devotee of Frederick II's Berlin chapter of a rabidly gnostic, Newton cult, which had been created by Venice's Paris-based spy-master, *Abbé* Antonio Conti (1677-1749). After Conti's death, the connections were maintained by Venice's notorious Italian asset, Francesco Algarotti,[1] by such other sub-agents as Voltaire and Giammaria Ortes. Euler's controlling role in the Berlin cell of Conti's network of Leibniz-hater sa-

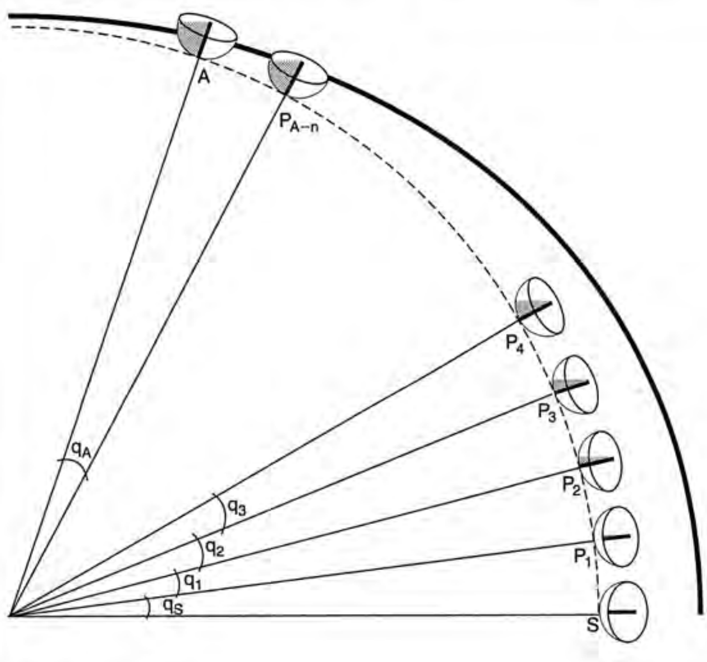


Figure 5
ERATOSTHENES AND RELATIVE CONSTANCY OF EARTH'S CURVATURE

Did Eratosthenes assume, in his experiment, that the arc defined by the difference between the two angles, corresponding to the distance from Syene to Alexandria, was a spherical one? Or did he take some precaution which gave him persuasive evidence that the arc was situated in a spherical geometry?

Compare the ratios among measured arc-intervals (into which arc $S \rightarrow A$ is divided by the placing of sundials), to the ratios of the differences in the angles subtending those arc-intervals. The construction of the experiment, shows that Eratosthenes designed the experiment in such an axiomatic way, as to provide for a simple geometrical determination of the relative degree of self-similar constancy of the rate of curvature along line $S \rightarrow A$.

lons, locates the proximate source of Euler's motive in perpetrating the hoaxes later associated with doctrines of "linearization of space-time in the infinitely small," and with the ensuing, purely mythical assertion, by empiricists and positivists, that the discovery of the transcendental quality of *pi* (π), is to be credited to the politically motivated, algebraic hoaxes perpetrated by Euler, Lambert, Hermite, Lindemann, *et al.*

The crux of the issue implicit in this issue of constant curvature in the small, is pinpointed by my reference to the concluding line of summation in Bernhard Riemann's 1854 habilitation, as referenced in footnote 14 [page 51]. I freely translate the two most relevant excerpts from within the second paragraph of the dissertation's concluding section 3.

Riemann begins that paragraph, by qualifying his ongoing argument there, that: "If one presumes, that a body exists independently of its position, then the measure of curvature is constant throughout, and, it then follows, from astronomical measurements, that that curvature can not deviate from zero. . . . However, when such independence of position does not occur, one can not accept the [presumption] that relations of measure (*Massverhältnissen*) in the macroscopic domain [apply] to the infinitesimal [domain]. . . . It is, therefore, plausible, that the relations of measure of spatial relations in the infinitesimal, do not conform to the presuppositions [for example, definitions, axioms, and postulates] of geometry. In fact, one would be reasonably compelled to that [view], as soon as this would permit the phenomena to be clarified in a simpler way."

Then, the concluding sentence of his dissertation wraps up the line of argument just referenced: "This leads us into the domain of another science, into the domain of physics, which the nature of today's occasion [on mathematics as such] does not permit us to enter."

The same point was repeatedly addressed by the same Gottfried Leibniz, whose contributions the political circumstances of 1854 Göttingen University did not permit professorial candidate Riemann to mention in safety. Notably, the entirety of Riemann's leading discoveries, including the habilitation dissertation and his later work on *Analysis Situs* and hypergeometry, are the product of Riemann's rich study of Leibniz's work,[2] a study whose fruit was powerfully enriched by the relevant additions by Carl Gauss, as, also, by Johannes Kepler. See Gauss, on such related topics as biquadratic residues, curvature, and hypergeometry; Leibniz's references to *Analysis Situs* are central features of this influence, as expressed, with great emphasis, in Riemann's habilitation dissertation, as, also in his leading later discoveries.

Leibniz's calculus, as presented to a Paris publisher in 1676, was developed in response to specifications supplied by, chiefly, Johannes Kepler, but also Blaise Pascal, before him. This arose, in Kepler's work, around the practical matter of determining the curvature of a non-circular (e.g., elliptical) planetary orbit. Thus, for Leibniz, the essence of the calculus, is the issue of *the determination of a non-constant curvature occurring within infinitestimal intervals,* just as this is the central practical mathematical feature of Riemann's habilitation dissertation. This is the central feature of young Carl Gauss's celebrated stroke of genius as a physicist, in determining the orbit of the asteroid Pallas; it is the basis for Gauss's subsequent, richer development of the science and practice of both geodesy and geomagnetism. This is the same issue which I am addressing here, respecting the implications of Eratosthenes' placing a series of sundials, at measured intervals, along an astrophysically determined, south-north line.

Leibniz's argument may be summed up: Given, a tangent to a line, located within the distance of some infinitesimal point of the process which that line is constructed to represent; how do we measure the non-constant curvature of that entire line, by means of local non-constant curvature within the infinitesimal region associated with that tangency? Thus, the devastatingly destructive implications for science of the fraud of "linearity in the small," as assumed by *Abbé* Antonio Conti's English agent, Dr. Samuel Clarke, as developed by Leibniz-hater Leonhard Euler, and, as passed from Euler, through Lambert and Lagrange, along the Laplace-Cauchy-Clausius-Hemholtz sewer-pipe of reductionism, into the intellectual cesspool of contemporary radical empiricism.

This idea was not original to Leibniz, nor to the Kepler who inspired the calculus as an intended access to solutions for precisely this mathematical problem. Its origins in modern science are found in the work which founded modern European experimental physics, Cardinal Nicholas of Cusa's *De docta ignorantia.* This is a matter addressed, once more, in the paper referenced by this commentary on Eratosthenes' principal contribution to the roots of modern geodesy. The modern history of treatment of this problem of non-constant curvature, began with Cusa's original discovery of a crucial sub-class of incommensurables, later termed, by Gottfried Leibniz and his associates, as "non-algebraic" magnitudes, or "transcendentals." Cusa proved the existence of such magnitudes for the case of the circle and sphere, by showing the relevant elementary error included in Archimedes' treatment of the subject of quadrature, as I recapitulated Cusa's argument, and its leading implications, in my 1992 "On the Subject of Metaphor."[3]

The solution to the problem posed by the problem of non-constant curvature posed by experimental physics, appeared on the horizon with Gauss's development of the principles and uses of biquadratic residues into a general theory of curved surfaces. Gauss's work gave a new, sane, experimental meaning to what had been the grotesquely mislabelled category of "imaginary numbers," and laid the basis for future advances into still higher orders of cardinalities.

Sometimes, what appears simple, is actually elementary; in that case, the issues involved are never simple.

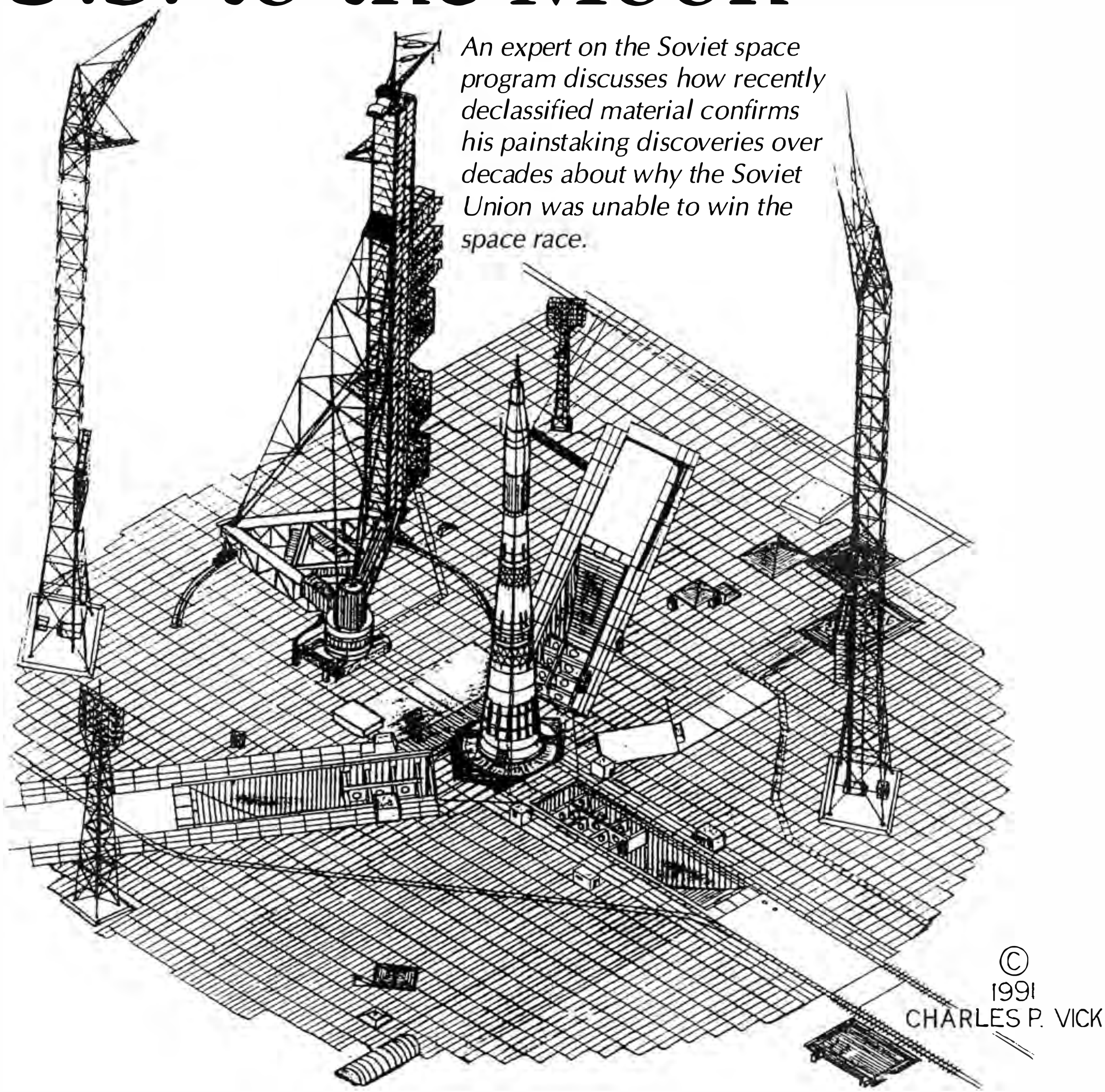
Notes

1. The author of *Il Newtonianismo per le dame* [Newtonianism for ladies], and artistic advisor for the design and decoration of Frederick II's Sans Souci palace.
2. E.g., on *Analysis Situs:* Loemker, pp. 248-258. See also, in the same volume, *Monadology,* pp. 643-53.
3. *Op. cit.*

INTERVIEW WITH CHARLES P. VICK

Why the Soviets Never Beat the U.S. to the Moon

An expert on the Soviet space program discusses how recently declassified material confirms his painstaking discoveries over decades about why the Soviet Union was unable to win the space race.



EDITOR'S NOTE

The Soviet Union was the only nation besides the United States that ever developed the ability to put man into space. The Soviets did it first. But they could not sustain an effort of such magnitude, because they were not able to transfer new technology from their civil and military space programs to the economy, as a whole. As space expert Charles Vick explains, the pie was limited in size by this failure, and when the political situation changed, other programs took priority over sending men to the Moon. Today, the Russians will doggedly try to maintain their space capabilities, Vick states, but time is running out.

Russia today is at a crossroads. If the current financial policies, under the heel of the International Monetary Fund, should continue, the one-time Soviet superpower will be relegated to Third World status, suffering the political and economic chaos that will result from such a devolution.

After his most recent trip to Russia in April 1997, during which he traveled throughout the country to various space facilities, Vick commented that the IMF policies in Russia "amount to economic tyranny." One result, he observed, has been the meteoric rise of corruption and criminality, and the corresponding lack of available resources for basic economic reconstruction, or the space program.

Soviet space expert, Charles P. Vick.

Vick, currently a senior research associate at the Federation of American Scientists, has more than 35 years of experience in assessing Soviet space technology. His technical drawings of Soviet launch and space vehicles are known worldwide. By applying his own creative powers to analyze whatever paltry data were available from the Soviets before 1989, Vick was the first to publish a drawing that reconstructed the N-1/L-3 Soviet manned lunar vehicle, at a time when the Soviets were denying that they ever had a manned lunar program.

Vick is now working to develop the seventh N-1/L-3 book-length study. He was interviewed in July by 21st Century *Associate Editor Marsha Freeman, who is the author of the book* How We Got to the Moon: The Story of the German Space Pioneers.

Question: The Soviets were the first in space, with the launch of Sputnik 40 years ago. They had the first man in space, as well. So, one of the greatest mysteries of the Soviet space program is why the Soviets never beat us to the Moon, and why they still have not sent people there to explore. When President Kennedy announced that the United States was making landing on the Moon its goal, it would seem to be undebatable that the Soviets were likewise planning to have a manned lunar mission. Were they planning it before Kennedy's announcement?

A 1991 drawing by Charles Vick of the N-1 booster with its L-3 lunar payload, on the launch pad at the Baikonur Cosmodrome in Kazakhstan.

They were in fact planning it ahead of time. What is even more interesting is that when Kennedy made his speech, the Russians did not completely understand what he was saying, and it took them some years before they actually completely understood. Once they did, then they said, "Oh. Wait a minute. We've got to look at what we're doing." They were, however, committed to other priorities.

Question: Let's go back further, to when the Soviets would have been first thinking about landing men on the Moon.

Their plan is rather self-evident, when you go back and look at their open literature, even back into the 1950s. You have to consider the fact that the Germans had the idea, and the Americans also had the thought. It was in the general, open literature going back before World War II. The Moon has always been an interesting subject.

Their lunar program was more evident once we started seeing the Russians flying unmanned lunar missions in the late 1950s and early 1960s. Plus, their other public statements made it very clear that something was going on. But not until 1963 did we really have anything solid and official, built around a series of statements by Nikita Khrushchev, that really revealed there was something going on. Ultimately, you find that our side was looking for the evidence, and not finding it, until August 1963, and we were not really certain until the fall of 1964.

Question: What was it that the United States saw in August 1963?

The beginning of the construction of the Baikonur Cosmodrome, of the TT-5, or what would become known as the J facilities. That's when the first road work and stakes in the ground were going into place. The National Intelligence Estimate of 1965, from the U.S. Central Intelligence Agency, which has not been released, reviews this. It is mentioned in the 1967 National Intelligence Estimate on Russian space programs, which has been released. This is confirmed by the now-declassified reconnaissance film from the Corona camera.

Even more interesting is the fact that when you compare their initial dates to what you see in the reconnaissance pictures, there can be a wide gap between when they say construction started and what the pictures show. This may be due to the fact that, of course, they have to prepare the ground and put the roads into the general area, and once they actually get the ground prepared, then, they say, "Now we're really starting construction for real." But, in fact, construction had started much, much earlier.

Up to that point, frankly, America was looking for the evidence and saying: "Are they going to give us a sporting race, or aren't they?" We weren't seeing it in the literal sense. But Khrushchev tipped his hand about the same time as these thing were going on, so things had gotten started and we began to see it.

NASA Administrator James Webb, made statements in April and May 1964 in which he said he was not certain that they were racing us at all. In a speech to the Missouri Cotton Producers Association in May 1964, Webb said, "There is some evidence the Soviets are working on a larger rocket, but we cannot say yet for sure." But in an article on Oct. 14, *Washington Post* writer Howard Simons reports Webb saying, "there is increasing evidence" that a new, super rocket was being readied for testing, in the 1967-1968 time frame.

Question: So we could see certain activity, and then later Khrushchev started making public statements saying they were going to try to land men on the Moon?

His statements were very devious, and occurred in the fall of 1963, when there was discussion by President Kennedy about the potential for cooperative missions. In fact, Kennedy, in August 1963, mandated a reduction in the level of confrontation with the Russians, and looked more toward cooperation with them. That was government policy. Many people were circling the wagons to protect their projects, including the Apollo program at NASA at that time, because we had not seen evidence up to then that the Russians were undertaking a lunar program.

But then Khrushchev made some statements that were not direct, but indirect, and there were arguments about whether they were, or were not, racing us to the Moon, depending on how reporters interpreted what Khrushchev said. And he twisted it around and around.

Ultimately, we ended up finding out that you have to look at the money: Follow the money and that tells you the truth.

What was really startling to me, was the realization that the Russian budget, up through 1963-1964, continued to rise for the lunar program. Then it became almost flat, through to about 1970, when they added about another 600 million rubles to it. And then, it dropped off from there slowly, systematically, until 1974, when the program was cancelled, although remnants of the program continued through March 1976 for a manned circumnavigation, and manned lunar landing program. It's just amazing to realize that the budget went up to a certain point, then went flat. Whereas, if you look at the strategic rocket area, the budget just kept right on skyrocketing, much above that of the United States. When you realize that the Soviets put the money into that program, and not into the space effort, you say, "Wait a minute. Is this a commitment by the government, or isn't it?"

In retrospect, the 1962-1964 period was critical to the events and decisions in the Soviet lunar program, as well as to commitments to the strategic rocket program. The advent of the U.S. Minuteman missile and Corona reconnaissance programs, forced the Soviets to make still larger outlays to create silo-based strategic ballistic missiles, with the ability to stay fueled in the ground, for a long time, in a ready state and with a quick reaction time. The second-generation missile systems, for which they had appropriated money, were already outdated before they were deployed, and the Soviets had to develop a third-generation system, which we would see deployed in the latter part of the 1960s.

As a result of the Cuban missile crisis, the legitimacy of the Soviet regime and the credibility of its strategic forces were being questioned. U.S. Defense Secretary and geopolitician Robert McNamara stated, after the Apollo announcement, that the Russians would have to choose between strategic systems and the space race. Our policy people hoped they would choose the space race, but they did not.

Question: Right after the war, the Soviets made the decision that they would be developing rocket technology for military purposes. In August 1957, there was the first successful test of their ICBM, and then Sputnik, in October 1957. What were they doing on a lunar program in that early period, and what approach were they taking to land a man on the Moon?

From 1957, and even earlier, as far back as 1955, Sergei Korolev [the chief designer of the N-1 booster and the manned lunar program] was doing design studies on a heavier-lift launch vehicle than the Sputnik R-7 booster, and the derivative forms of the R-7 booster evolved as the N-1 Moon rocket. A number of variations were also developed. The initial designs that Korolev developed were a multi-block vehicle, meaning multiple modules, much like the Sputnik booster. It has multiple parallel blocks. The N-1 had six parallel blocks and one sustainer block, and then booster stages on top of that.

Question: What do you mean by blocks? Is that stages?

Yes. It was a multiple-stage vehicle, and then they added upper stages to it. That was while they were doing design studies, until about the 1961-1962 time frame. They were looking at the rocket engines they were thinking about using. Those early rocket engines were open-cycle engines, which are not as efficient as closed-cycle engines.

Question: Can you explain the difference?

In the open-cycle engines the actuation gas used to run the turbo-pump, the substance that actually makes the pump spin, is dumped overboard. It's wasted energy. In the closed-cycle engine, that gas is dumped into the oxygen-rich thrust chamber and burned with the rest of the fuel. The Soviets suddenly realized in 1960-1961 that they could develop those high-pressure, closed-cycle engines and get a better launch vehicle. Using engines with increased efficiency led to a dramatic change in the design of the N-1.

When they compared the two different launch vehicles, using one engine type versus another, they went to a different structural type altogether. They finished those design studies officially in the July-September 1962 time frame. There are quite vivid descriptions of that in the open literature, published at the time. They were fascinating. They were arguing about the logistics of the vehicle, and how you get it to the Cosmodrome, and how you manufacture it, transport it, and so on.

Question: And that was published in the open literature?

It was indeed. Part of it was published in *The New York Times,* and was very revealing. It described a booster that was 55.8 feet across its base, with the first stage 150 feet long, in one design they were looking at. But they ended up breaking that up into three separate stages, because a vehicle that size would be exceptionally difficult to transport, in land-locked Russia.

Question: Similar to the Saturn V?

In some respects, but the shape and design of N-1 is dramatically different from the Saturn V. The first three stages of the N-1 actually constitute the first two stages of the Saturn V. The first stage in N-1 has a Nova, or super-Saturn/Nova-class launch vehicle written all over it, because its thrust was 10 million pounds-plus. There were 30 engines in its first stage, at 150-154 metric tons thrust each, giving it more than 10 million pounds of thrust at launch. By comparison, the Saturn V first stage had five engines, producing 7.6 million pounds of thrust.

The original N-1 design was of a somewhat smaller vehicle. The N-2 derivative of N-1 would have used the upper second stage of the N-1 for its first stage, then N-3 would have used the third stage of the N-1 as its first stage. That development was dropped, but should have been followed through; they could have finished development of the upper stages a lot sooner, having already successfully static-test-fired those in the late 1960s for the N-1. They were not able, ever, to static-test-fire the N-1 first stage. They did not have the facilities for that. They do not have them even today.

That is one of the major reasons that the first stage repeatedly failed in flight tests. It is a more catastrophic failure in flight than on a test stand, if it fails the wrong way, and there is no inflight destruction system, which the Russians, as a general rule, do not have. Their philosophy for inflight safety and destruction of the booster, if it fails, is very different from ours.

Until after the second flight test of N-1, which took place on July 3, 1969, the Soviets did not have a procedure whereby they could keep the engines running, just to clear the facility, before they allowed the booster to go on and fail. They wiped out an entire launch facility when they let a failing vehicle collapse on the launch pad in July 1969. The engines were on automatic command to be cut off, if there were a problem, just as it cleared the turning tower gantry. When the booster fell back on the ground, it cratered the launch pad, as well as the underground, multiple-story building that was the support facility for the vehicle.

Question: How could have they avoided doing that?

They could have avoided that by keeping the engines on, in spite of the engines' failing. If the computer is programmed right, and it considers things in a certain way, it will not shut down the engines, for safety reasons, until the booster gains enough altitude and clears the launch facility. In this case, the Soviets did not have that built into the program. They do now, in all their launch vehicles, but they learned the hard way.

Your heart just drops, when you watch that thing lift off, during the July 3, 1969, test launch. The N-1 rises up and clears the tower, and then all the engines but one shut off and it just starts dropping back on to the launch pad. Those engines were shut off automatically, because a fire had developed in the engine bay from the explosion of one engine at lift-off. It's unbelievable to see the films of that.

NASA

President John F. Kennedy, in a historic speech before a joint session of Congress on May 25, 1961, declared, "I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth."

Question: I was unaware that they were not able to static-test those engines.

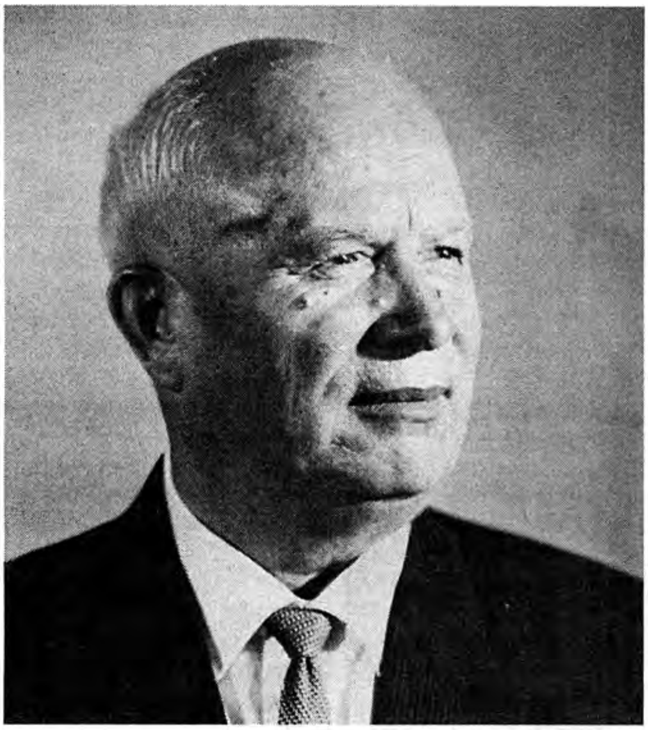
They did static-test-fire a selected few of the engines. They had a batch-production capability. They'd produce so many engines, and take X number of them and test fire them. If they worked, they'd install the rest of the engines. That's the way they did it with the first stage. The first stage was originally designed for 24 engines, but had 6 additional engines added to it, and then 4 additional Vernier engines, for a total of 34 engines in the final design for the first stage.

Question: Didn't they look into using more efficient liquid hydrogen engines?

They were looking at it and developing the technology, but they were way behind the United States. Some papers were just released in Moscow on that, but I do not have them yet. We do know that Nikolai Kuznetsov, at his design bureau in Kyubyshev (now, Samara), was working on a hydrogen engine concept. M.A. Lyulka Engine Design Bureau, did successfully develop an engine, known as the D-57, D-57M, which was one of the many engines that have been proposed. It was designed to be applied to an upper stage for N-1. But the engines they actually tested all used kerosene for fuel, and liquid oxygen.

The Soviets developed whole families of engines for the N-1, and other programs. Many other engines were actually involved, wholly separate of the manned spacecraft.

The first three stages of the booster are known as N-1. When you get into the fourth and fifth stage, and then the lunar module and the lunar orbiting spacecraft, and the big, huge shroud



Communist Party Secretary Nikita Khrushchev, in 1964, when the decision was made to modernize Soviet strategic capabilities and lower the priority of the manned lunar mission.

that goes over that, that's known as L-3. So it's called N-1/L-3, for lunar missions. The lunar part was a separate package and, in fact, they parallel-processed both vehicles, the L-3 and N-1, as separate packages, in order to process the vehicle.

From 1962 through 1967, the design underwent repeated changes. N-1 was initially designed to deliver 45 metric tons of payload to low-Earth orbit. Then it was redesigned for 75 metric tons, and then it edged up to about 92 metric tons, and, ultimately, 100 metric tons, by 1972.

Question: That would make it comparable to the Saturn V?

Close to it. Saturn had a capability of delivering between 130 to 140 metric tons of payload to low-Earth orbit, and N-1 was comparable, but not as capable. This difference in payload capability meant that the Soviets would have been able to place only one man on the lunar surface, not two men, as we did in each Apollo mission. Their lunar module was designed for merely one man, not two; it was very tight inside. It was designed as a one-man lunar excursion module to go to the surface, and the vehicle was different from the way we did it.

In addition, the Soviets were launching at 50 to 51 degrees inclination to the equator out of the Baikonur Cosmodrome in Kazakhstan, going north to skirt the Chinese border, not going due east as we do from the Kennedy Space Center at 28 degrees. That really cuts into the launch vehicle's optimum performance capability. Because they launch at such a high inclination, they have to also do a plane change in order to go to the Moon, and it takes a lot of energy to do that.

The Soviet lunar-orbiting spacecraft was a two-man spacecraft. What would have been the third man's seat was to be taken up by the lunar samples. The lunar cabin, or module, involved the Block D rocket stage—which on Proton is its fourth stage, and on the N-1 is the fifth stage. Block D was designed to use a kerosene and liquid oxygen engine, RD-58M, to break the spacecraft into lunar orbit, and to refine that orbit, down to about 10 km above the lunar surface. Then, the Block D engine, with the lunar lander on top, would fire for the last time, to start the direct-powered descent to the lunar surface. For the last 1.5 to 2 km prior to landing, the lunar cabin would have separated from the lunar braking module, Block D, and done the final powered descent and maneuvering to landing, from about 1.5 km altitude, down to the lunar surface.

Question: We had a lot of discussion in this country of how to do the Apollo landings. We considered Earth-orbit rendezvous, direct descent, and lunar-orbit rendezvous. We decided on lunar-orbit rendezvous.

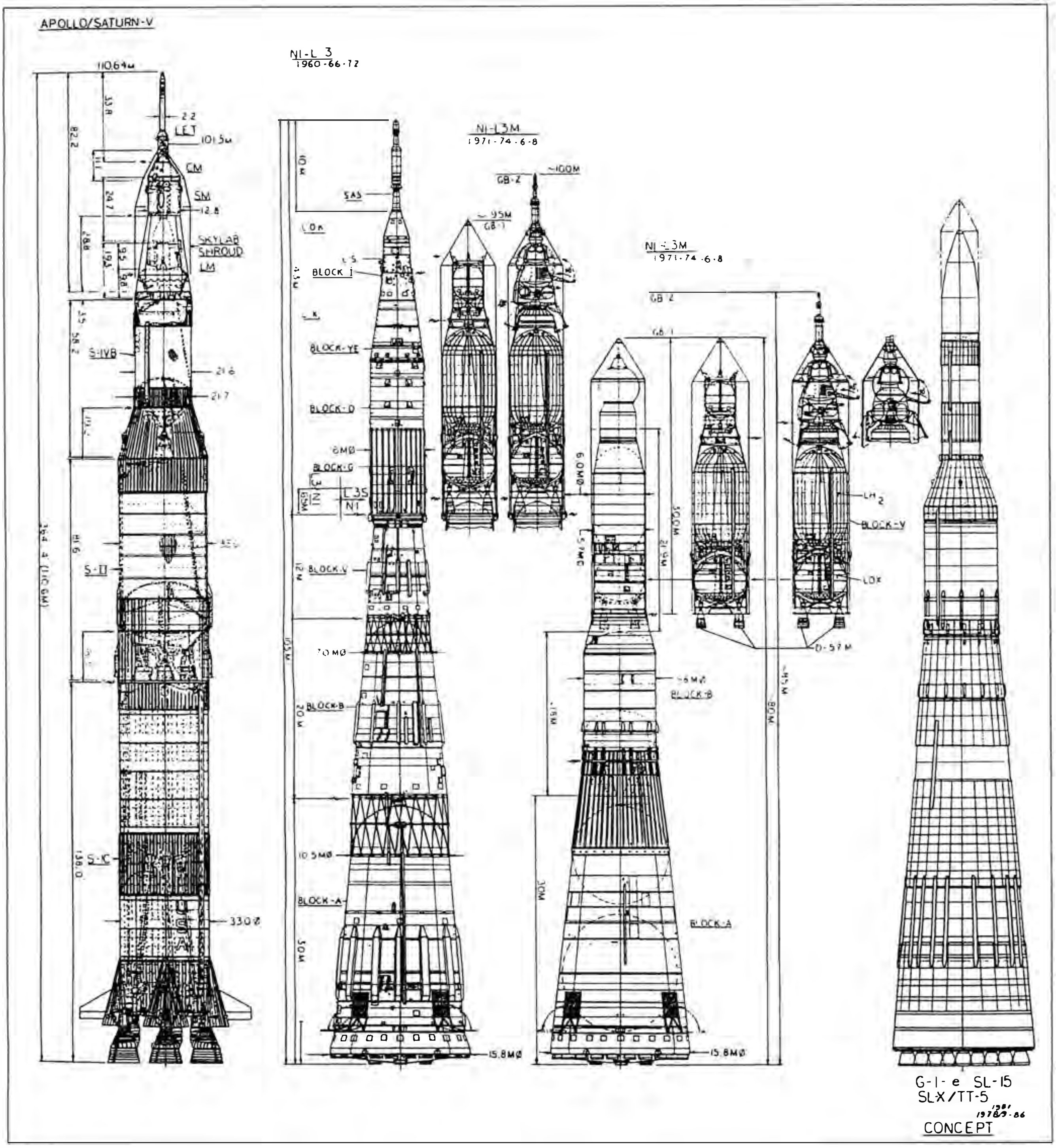
A Soviet technique, at that. Ultimately theirs would have been lunar-orbit rendezvous, but it was also lunar-surface rendezvous. As we understand it today, Korolev's last directions before he died in January 1966, would have involved at least two N-1 launches and several unmanned Lunakhod launches also. Lunakhod, meaning "Moon walker," was a rover that the Soviets used, designed to accompany cosmonauts on exploring the Moon. Korolev's program required multiple-launches, and had backups all the way around for the entire mission.

The Americans did their own separate studies of Earth-orbital rendezvous, direct, and lunar-orbital rendezvous. Lunar-orbital rendezvous ultimately turned out to be the best option. The Soviets themselves had done lunar surface rendezvous, direct launch, Earth-orbital rendezvous, and, later, lunar-orbital rendezvous studies.

But when the United States actually did it, and the Soviets sat down and looked at the figures, they considered our concept of lunar-orbital rendezvous to be particularly brilliant, to quote Alexei Leonov. Only later did they—and we—discover that a Russian had presented the concept many years before, and done the mathematics. They backed away from the Earth-orbital rendezvous and direct concepts, and went instead to what became lunar-orbital rendezvous and lunar-surface rendezvous, for themselves.

That would have involved two different kinds of launch vehicles. Prior to the N-1 launches, they would have launched at least one or two Lunakhod unmanned precursor surface-exploration vehicles on the Proton rocket, and landed in the general areas where they planned to do the manned lunar landing. The unmanned Lunakhods would have acted as radio beacons for targetting the landing area. Then, the Soviets would have launched an *unmanned* N-1, with full lunar equipment, and landed a lunar module, or cabin, in that preselected area for landing. That would have effectively provided an unmanned vehicle, approximately 28 days before the next mission, and the Lunakhods would have been able to inspect the lunar module, to see that it was okay. The Lunakhods would then back off from the site, in order to get pictures of the area.

In the manned lunar mission itself, which was planned to be launched 28 days later, the Soviets would have done a powered descent with the Block D. That is, a constant burn, constant thrust descent, in which very quickly, all of your forward velocity is lost and you come down almost vertically. This al-



Charles P. Vick

This series of comparative diagrams of the Saturn V Apollo rocket and the Soviet N-1 with its lunar stages, was drawn by Charles Vick between 1978 and 1993, from the very limited open literature available to the public before the fall of the Soviet Union.

lows you to see your landing point very precisely, and to maneuver to see the target, very early on.

Question: Because it's right underneath you?

Right. It's a near-vertical landing procedure. In the Apollo program, we used a gradual, throttled powered descent to the landing point, which is an elliptical approach. The Soviet constant-burn approach is a vertical landing profile that requires less energy, but can be far more dangerous. But they felt that they could do this, and had demonstrated the lunar module in Earth-orbit in 1971 and 1972 quite successfully, through three flight tests. The Block D was tested at least once in a flight test, besides its unmanned lunar missions, and Zond circumnavigation precursor missions.

Question: Was this a direct descent, or would they have gone into lunar orbit first?

They would have gone into lunar orbit first, and the lunar orbiter would have been there along with the other [back-up] one, the unmanned one, in the same general vicinity. Rendezvous was required. Cosmonaut Alexei Leonov has said there was an incredible series of rendezvous required for the lunar mission. There are two vehicles, and two rendezvous—one on the lunar surface and one in lunar orbit—as well as one coming back from the lunar surface to rendezvous and dock with the spacecraft that is in lunar orbit. It's very complicated in that respect.

But as far back as 1965, the Soviets knew from their guidance people that they could land them within a 5-km ellipse of the landing point on the lunar surface. That was the guidance parameter they had to work with. By 1969, they had reduced that down to 2.5-km guidance quality. The cosmonauts were required to be able to walk across the lunar surface, with their lunar suits on, over to the back-up lunar module, if the first lunar module failed. They also looked into using a Lunakhod rover, which would carry a man across the lunar surface to the back-up lunar module. So it wasn't exactly like landing one lunar module on top of another one, so to speak; there was some distance between them.

Question: Is the reason this is so much more complicated than what we did in the Apollo program, the fact that their launch capability would not have allowed them to take as much payload along in one launch?

It's more the safety factor, in every sense of the word. They really did not trust their equipment that much. Rendezvous in lunar orbit really scared the heck out of them. They did a lot of revisions and avionics work, as well as forward vision capability systems for doing that. They would have the unmanned orbiting spacecraft as a back-up. It's the standard package that they had developed, crazy as it may seem.

The question becomes, once they had actually successfully launched an N-1, would Soviet First Secretary Leonid Brezhnev have given the orders to go with the manned lunar landing, regardless of whether everything else was in place? The bottom line is that, for political reasons, the mission would have been conducted with one single launch, with no lunar surface rendezvous available to it.

Question: As the time got shorter, and they wanted to see results, they would have gone ahead and done it, without the redundancy?

Right. That is what is indicated. Brezhnev was making demands, and then, after a certain point, the doctrinal policies changed in Russia; as detente developed, in the early 1970s, the lunar program really lost favor. One, the Soviet Union had lost the race, and two, the program was way behind schedule, so since it couldn't come off, it wasn't worthwhile. Also, there were other programs that could be done that were already flying, such as the Salyut space station, which evolved into today's Mir space station.

Question: You've described a very expensive scenario for how the Soviets were planning to do their manned lunar program, having double vehicles and unmanned launches before they would send people. How did that change?

It changed because of economics and the limits of the program, and the problems they were having with the booster itself. The Soviets actually had five flight-test vehicles, the first one of which was expected to be flight-tested in the August-October 1968 time frame. As they built up to that flight test, in June 1968, hairline cracks developed in the huge, first-stage liquid oxygen tank, and that first stage had to be cannibalized. So everything was delayed until Feb. 21, 1969, when they finally flew the first vehicle. The United States did not understand, or successfully interpret and detect, that launch. The British did, through national security facilities, but it was never accepted by the intelligence community on this side. So, in effect, the Soviets did a flight test, and we didn't know it.

Question: Was that first flight test successful?

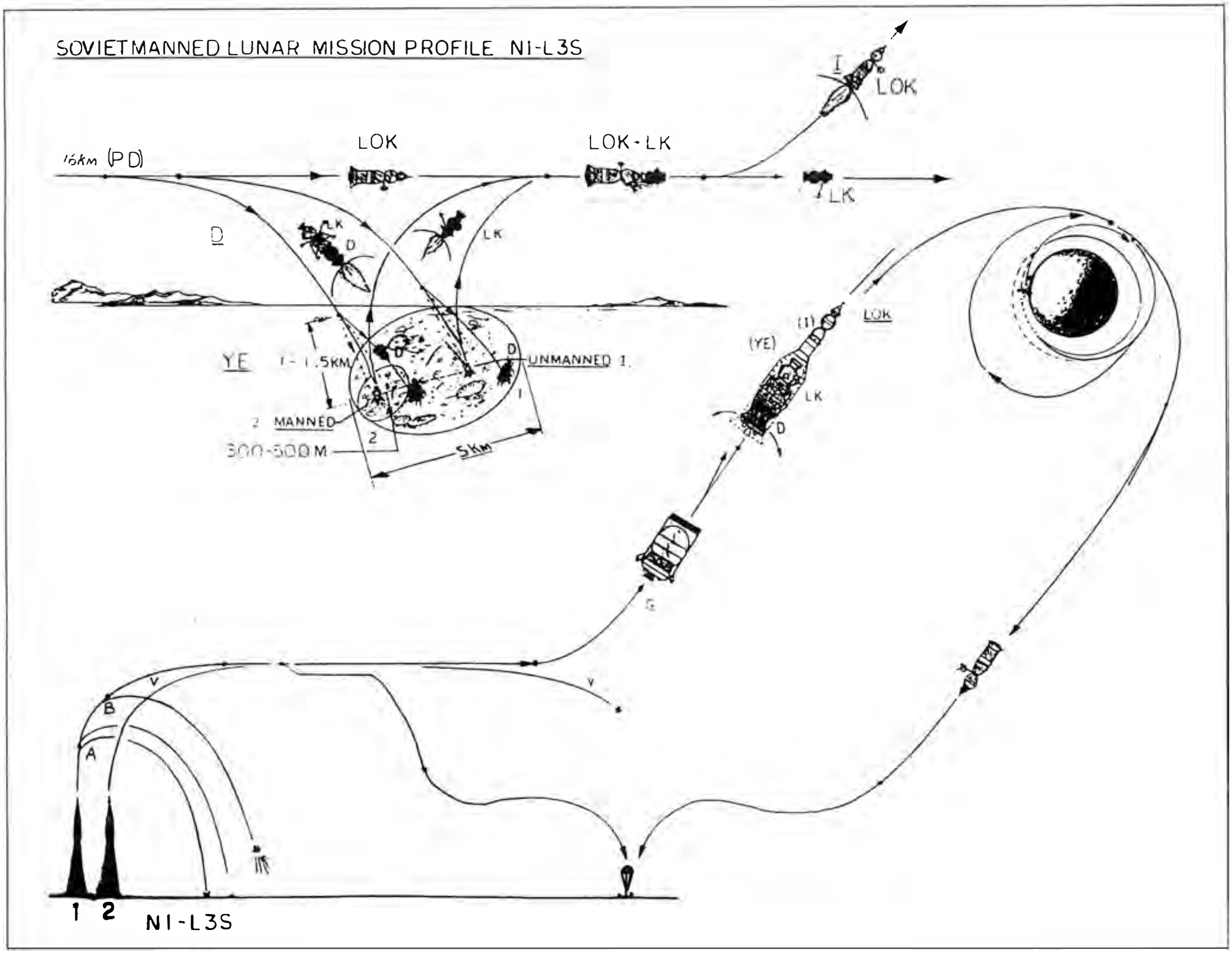
It lasted through 40,000 feet, before the first stage failed, because of engine vibration and the rupture of some propellant lines, which created a fire. A false signal was then given by the KORD [Engine Operation Control System], shutting off the engines. One engine had failed, and the control system was supposed to shut off two opposite pairs of engines to maintain balance. This was an aerospike design. If you shut off an engine on one side, you have to shut off the exact opposite engine on the other side. But when the KORD instrumentation failed, it shut *all* the engines off. The booster began to break up from the tail end. Then the launch escape system pulled the spacecraft free at the top of the stack, away from the rest of the L-3 portion of the vehicle, which started breaking up.

But the first stage kept right on burning for some time, until it went ballistic. I think the first and second stages kept right on going for a little while, until it didn't have any guidance system to guide it. The rest of it had all broken off. It's very dramatic to watch that arching failure. You see it going fine, and then, poof! The launch escape tower pulls away from the booster, and everything just starts coming apart. Then you finally see range safety blow it up, several minutes later.

Question: What is an aerospike engine?

The N-1 first stage was a very advanced propulsion concept. In its original design, when it had 24 engines, they were atmosphere-adapting aerospike engines, much like that being considered for the Space Lifter X-33 concept that NASA is looking at, even though it has some technical problems—a lot more than NASA understands at this point, I think. The aerospike atmospherically adapts and increases thrust as the atmosphere gets thinner.

There is an Achilles' heel to the aerospike design, and the Russians learned this the hard way, with N-1, in two ways. One is the thermal load required to create a nozzle in which you have multiple rocket engines burning on the outside. You have a long nozzle that the expanding gas goes against, to create the thrust that you want. That nozzle has to be cooled. The thermal loads, the energy loss from that cooling in the aerospike design, veto any possibility of acquiring a better performance capability out of the N-1 booster, compared to using six additional engines with standard nozzles on them. The So-



Charles P. Vick

The Soviet manned lunar mission would have used the first three stages of the N-1 (A, B, and V at lower left) to gain orbital altitude, and then the G stage to put it on a translunar trajectory. Block D would have taken the spacecraft into lunar orbit and then to the lunar surface.

viets learned the hard way, that if you have too much surface area for that nozzle, the energy lost in cooling actually vetoes the performance.

There's also another aspect.

When the Russians transitioned to the 6 additional engines in the center, within the 24 engines, they didn't make all the revisions required to preclude the entire engine boat-tail operating as an aerospike. That produced the aerodynamic effects with the third flight test that were the hair-trigger that created that failure. The gas was coming in from the sides of the booster, as it rose up from the launch pad, and from the shock wave coming up from the bottom of it.

During the second flight test, some debris—bolts, nuts, or whatever from manufacturing—got into one or two of the engines and caused a fire to break out in the first stage. This happened to a Space Shuttle main engine that blew up on a test stand in the late 1970s, and that's what happened in the N-1 engine bay, when the oxygen line ruptured and fuel dumped all over everything. Because everything was hot, the engine exploded into fire.

You can see the fire developing as the N-1 lifted off and cleared the tower. Soon after, the automatic control system shut off all but one engine. That explosion had, in fact, cut the lines that would have shut off that engine, so the engine couldn't be cut off. That one engine tipped the N-1 over on its side, and it collapsed sideways and fishtailed, dropping back on the facility and doing the tremendous damage that we have seen in the declassified Corona photo reconnaissance pictures.

The third flight test was on June 27, 1971. It lifted off and failed almost immediately, when an after-effect, a shock wave produced by the acoustic gas pressure, travelled back up the vehicle—much as we have with the Shuttle—and sent the booster spinning about its center line. The interstage, between the second- and third-stage structure actually broke, and the top of the booster started falling off. As the booster continued to climb out, it gained some stability, but the whole L-3 unit started flipping over. Ultimately, the front end broke off, and the booster broke up at that time.

Apparently all the launch-escape systems did work as they should, and it is certainly very dramatic. Thank goodness that it did work that way, because you wouldn't have wanted to be around when that thing collapsed on the pad: It gouged out a 90-foot crater, about 20 km downrange.

I think the most dramatic pictures I have ever seen are the pictures I saw in Russia when I was there in April 1997, of the fourth, and final, flight test of N-1, on Nov. 23, 1972. It had almost worked through the entire first stage burn; it failed in the last few seconds, about 10 seconds after completing its first stage burn and going to the second stage. The programming was such that it could not start the second stage, in spite of the first stage having failed at the last minute, during the center engine shut-down procedure. There are 6 center engines and 24 outer engines, plus four Vernier engines on this fourth version of the vehicle.

You watch the vehicle lift off; it's clean, it's beautiful, and you can't believe how much fire and intensity of energy there is in the flame trench. The vehicle completely clears the facility and the flame trench; the concrete is still glowing yellow, well after the vehicle has cleared the facility. I have never, ever, seen anything like that before. That had to play hell with the concrete . . . just the very energy involved in that blast furnace.

When they shut down the center six engines, there was a propellant line that fed some of the gas generator systems on the engines which ruptured. It started a fire that spread very rapidly. The severe pogo vibrations broke up everything at that point. The vehicle failed, and the engines were shut down by the KORD engine control system again. The second stage was not started. They never blew the booster up. They let it go completely ballistic downrange, some 200 to 500 km, and crash there. I'm sure some parts broke off, but a large portion of the vehicle went all the way downrange, crashed, and exploded.

Question: This answers the question of why the Soviets were never able to send people to the Moon. What was the reason that in the mid-1960s the money was not available for this program?

You end up saying to yourself, "Was the lunar race real?" Yes, and no. It's a very ambiguous answer. There was clearly a greater priority than the lunar mission, and perhaps the Russian leadership felt that they had to keep the Americans in the lunar race to keep them away from the strategic rocket game. If they could keep us occupied with the lunar effort, it would make us divert a lot of funds that would have gone, perhaps, into more strategic rocket or military programs.

Question: But by that time didn't the United States have an overwhelming military superiority?

We had the superiority and the capability, and they didn't. To a degree, they wanted to slow us down, stop us, and keep us occupied. At the same time, there was no separation between *their* military and space programs. Their whole space program was based on the surge capacity boosters that they produced for the military. They were made available for the space program because they were excess production. A number of boosters were made available every year, and the space program grew, over and beyond the already committed military programs, through those years.

It's amazing they were able to do what they did. To a large degree, when you look at the appropriations level, you realize that Korolev had challenged the leadership in Russia well before he died in January 1966, even before Khrushchev went out of office. He said, "Are we going to do this, or aren't we going to do this?" The ultimate answer was, "Yes, we're going to do this, but this is all the money you're going to get. And you're going to have to make due with that." That's the way it was done. They went on to do the work, and I'd have to say that, so far as the government was really concerned, for all practical purposes, there was no lunar race.

But the scientists themselves with the tremendous effort that they put out, at what became the Energia Company of today, actually turned it into a lunar race—a very close one, in a lot of respects. "They had all the wrong failures at the wrong time, and we had all the right ones," to quote Dr. Charles Sheldon, former chief of the Science Policy Research division, of the Congressional Research Service at the Library of Congress. If the opposite had been the case, it may have been a very different picture.

Question: Were our failures early enough in the program so that we still had enough time to correct them?

That's right, and we did thorough ground testing, which the Russians were not able to do. They were able to test fire all the upper stages of N-1 and all the payloads, and flight test all that equipment, as a general rule. But they did not have the test stands for the entire launch vehicle stack to be dynamically tested, although they did it in subscale form. They did all the testing in Korolev, formerly known as Kaliningrad, in the Moscow area. They did test firings of the first stage at Zagorsk, outside of Moscow, and then did other tests at Baikonur, which is where they ended up building the boosters' first two or three stages.

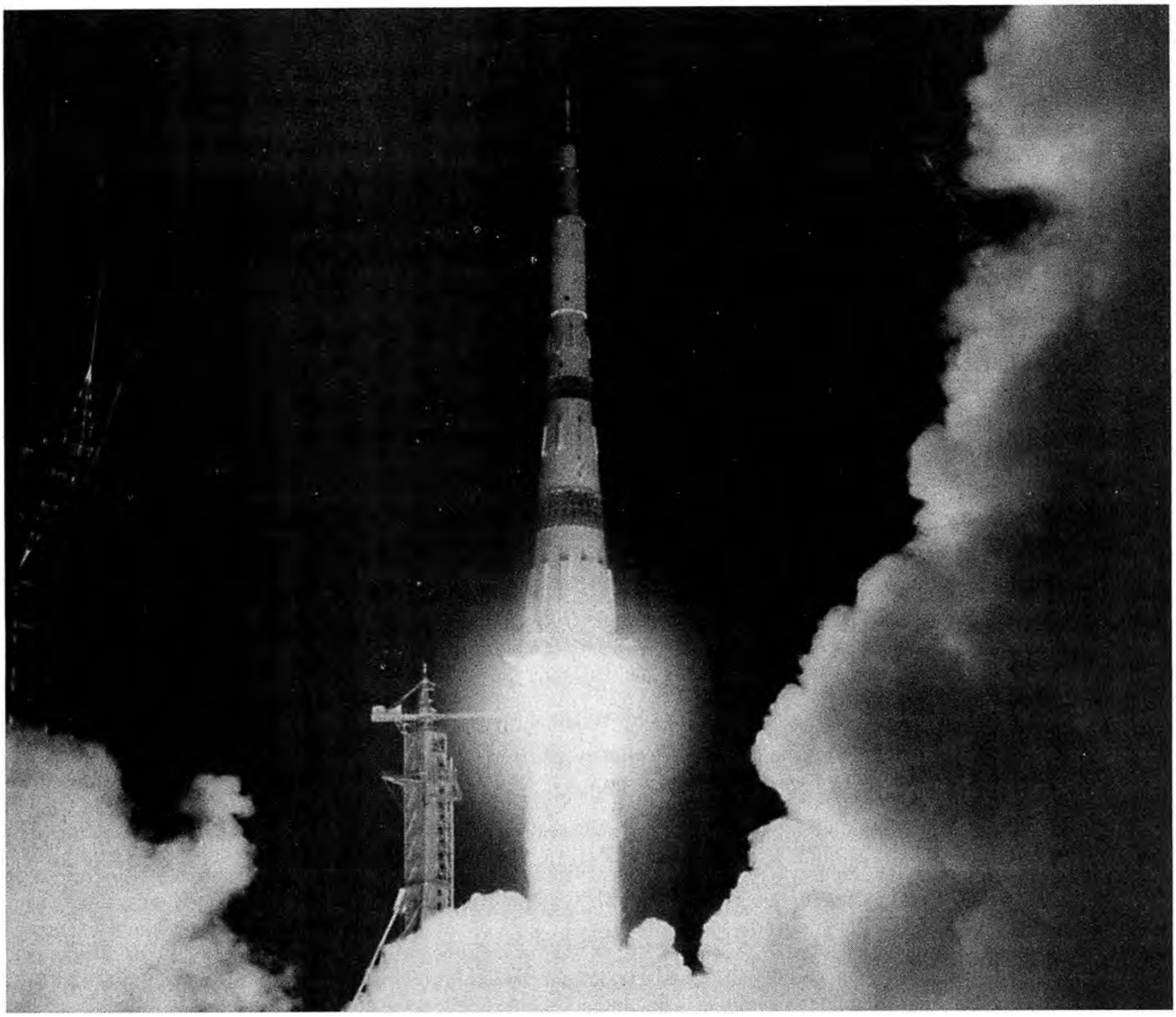
The rest of it was built elsewhere in Russia, primarily Samara, and shipped by either air or railroad to the launch site. The first and second stages were built off-site at the Cosmodrome inside the N-1/Energia assembly building. In fact, the facilities are still there and are available for use for the Energia booster.

In Samara, the Soviets destroyed a total of seven boosters. At Baikonur, they destroyed six boosters, over and above the four flight test vehicles, plus the scrapped first stage of a flight test vehicle. They had ground-test vehicles and dynamic-test vehicles. They broke three dynamic test stages at the Cosmodrome. They are very proud of that. They broke them during structural dynamic testing, to find the limit. And they broke the flight test vehicles, too.

Question: One of the incidents that, it is said, had an impact on the lunar program, was the death of Korolev in early 1966.

If Korolev had lived, it would not have made any difference in the lunar effort. The Soviets were two-and-a-half to five years behind U.S. developments, which we had already started in the 1950s. Khrushchev started the space race, but one would have to legitimately say that he also ended the space race, when the decision was made to put the appropriations into the strategic rocket programs.

But it is *amazing* what the Academy of Sciences and the



RSC Energia, Korolev, Russia

An N-1 test vehicle with the L-3 lunar stage on top, lifts off the launch pad at Baikonur. None of the four test flights was successful.

Russians managed to accomplish—the sheer momentum of what Korolev and the Academy of Sciences had started. By the time Korolev died in January 1966, things were beginning to come apart for him. Even if he had lived, they would not have beaten us to the Moon. N-1 would not have been ready on time.

In terms of propulsion, the United States was already working on the F-1-class engine and hydrogen/oxygen engines, which were used on the Saturn V, back in the 1950s. The hydrogen work was done by Aerojet initially, and other work was done by Pratt and Whitney. This work led to the J-2 engine, which was used on the second and third stages of the Saturn V. Rocketdyne did the work on the E-1 engine, which was a buildup to the F-1, at a half-million pounds of thrust.

Both countries had considerable problems with rocket engines, kerosene/liquid oxygen, or LOX engines, because of rough combustion. We took quite a few years—until the late 1960s, early 1970s—to learn what is known as the "rough combustion curve." If certain parameters of design are outside this curve, you won't get rough combustion in the thrust chamber; if the design parameters are inside, you will have rough combustion. It took a long time to learn that. But the Soviets developed a very robust engine that is being applied to American commercial launch vehicles today—NK-33 and the NK-43—which could even stand rough combustion.

You might ask, why so many engines? It was what was possible to be developed in the time frame required. There was also a very severe argument between Valentin Glushko and Korolev. Glushko, who headed the Soviets' prestigious Gas Dynamics Laboratory, refused to build kerosene/LOX engines, and would only build storable propellant engines for Korolev's launch vehicle for the lunar effort. There were discretionary funds available for storable propellant engines, for the military, which was using storage propellants.

RSC Energia, Korolev, Russia

Sergei P. Korolev, sometimes referred to as the Soviet Wernher von Braun, was the chief designer of the N-1 booster and the manned lunar program. Today his design bureau is known as RSC Energia.

Question: What are storable propellants?

I'm thinking about UDMH [unsymmetrical dimethylmethylhydrazine] and nitrogen tetroxide, storable hypergolics. They can be stored in a normal environment chamber, but they're highly toxic and very harmful to human beings; they can kill you, if breathed in. When UDMH and nitric acid come together, they explode instantly into flames.

The other approach uses kerosene and liquid oxygen, LOX. The LOX is cryogenically cooled, and the kerosene is storable and can be super-cooled to a degree. The kerosene the Soviets use, which they still use today, is actually a derivative of gasoline. It's more gummy than our kerosene. Kerosene works quite well with those engines. The differences are really very small, as has been demonstrated in test firings in the United States.

Glushko refused to develop kerosene engines because he didn't think that a 150-metric-ton thrust engine using kerosene/LOX could be developed. He essentially refused to do it.

Question: It seems that an important factor in the Soviet lunar program was the competition that was maintained and fostered by the government between the different design bureaus. How did this affect the progress of the lunar program?

Few people realize that Stalin, a long time ago, gave the chief designers the right to refuse to do a project or be a part of a project, without penalty. When a General-Designer is appointed, it is a rank, a military rank, quite literally. And when they're appointed, they are appointed for life. They are gods.

There were the various aircraft design bureaus. Korolev was a General-Designer. The person who succeeded him, Vasily Mishin, was a General-Designer. Glushko became a General-Designer of rocket engines. Vladimir Chelomei was a General-Designer, who also had the UR-700/LK-1 competitive design to Korolev's lunar design. Mikhail Yangel was also a General-Designer with his design bureau in Ukraine; he had the R-56, based on the R-46 super-ICBM concept, another competitive design to Korolev's N-1.

Yangel was initially developing the R-46 super-ICBM, as Chelomei was developing the UR-500 super-ICBM "city buster," as vehicles this size used to be called. They were designed for a 150-megaton warhead that was doctrinally in favor in the early 1960s. Chelomei's UR-500, later the Proton, won the contract; the R-46 was dropped.

But then, the lunar contract came along. Khrushchev had developed this technique of having competitive contracts, supposedly to get better designs. Initially, looking at the lunar booster, they had selected a booster for the program, but then the competitive boosters were presented midstream, when N-1 was already under development and facilities were being built.

At the same time, money was being spent on those competing programs, and wasted. The chief designers were literally out of control at that point, and the government did not rein them in, except that the R-56 was dropped when Mishin, Korolev's successor, wrote letters complaining about it to the Ministry of General Machine Building, which ran the space program starting in 1965-1966, with the new Five Year Plan.

This so-called competition was very destructive, because people were not working as a single team, for a single goal, on a single vehicle. They were saying: "I'm going to work on this. He's going to work on that. Mishin can do what he wants to do, but we're going to do our thing."

There also were the unmanned lunar programs, including the automatic sample programs, and the Lunakhod program, plus the Zond circumnavigation program. So there were more than half a dozen manned and unmanned lunar programs in progress at the same time, in very intensely competing organizations. Pure chaos. It made it very difficult for Mishin, who succeeded Korolev as General-Designer of what eventually became Energia, because he had all these competitors to the N-1, and he didn't have the money he needed.

Mishin would make recommendations that they build test stands for the first stage, or do testing, or put on certain kinds of instrumentation to be certain that the engines were performing. Some of the instrumentation he was suggesting was very advanced for rocket engine performance observation—much of which we still do not have perfected, even today. Their computer technology was *not* the best in the world. Their instrument control technology for N-1 was very advanced thinking, but it just was not right. It would have been perfected over time. I think with the fifth flight test, they would have finally successfully flight-tested the booster. But Mishin never got the support he needed for these efforts.

A lot of people said Mishin messed up the management and everything else. You have to realize that he had 25-plus programs dumped on him when Korolev died. And he had a lot of people reporting to him, directly. It took him a while before he began to delegate authority, and he got reprimanded by the Ministry of General Machine Building for it. The actual development of N-1 was going at about the pace you would expect for development of a booster, looking at the limitations of the

Russia's Commitment to Repair the Mir

On June 25, an unmanned Progress supply ship collided with the Spektr module on the Russian Mir space station, damaging the large solar array attached to Spektr, and puncturing the radiator on the body of the laboratory. Immediately, the entire space station lost about half its electricity. The Spektr module lost its atmosphere, and along with it, the scientific experiments that U.S. astronaut Michael Foale had been conducting during his stay aboard the station. This and a series of other mishaps, have kept two different cosmonaut/astronaut crews busy.

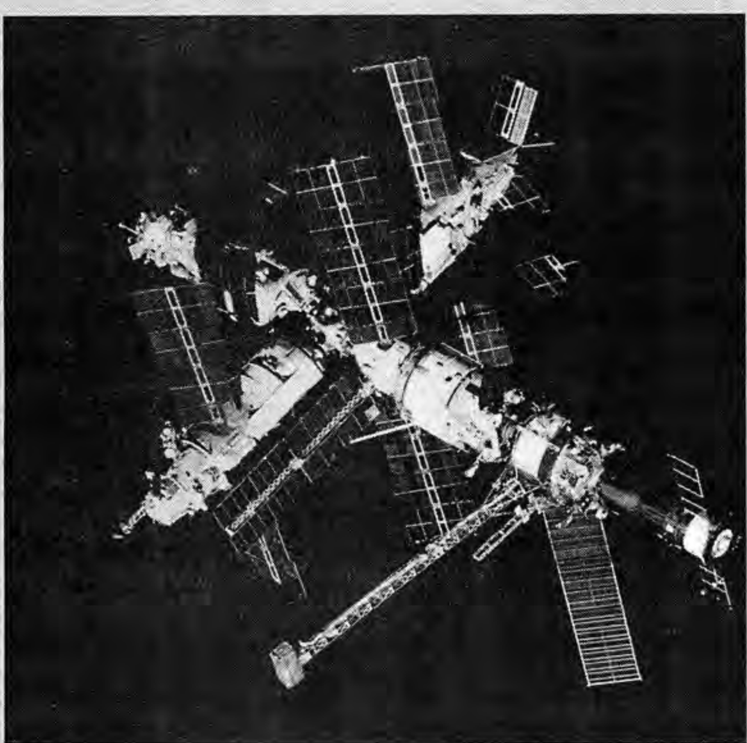
Immediately after the accident, there were calls from neoconservatives, and others who have opposed the Russia/U.S. space cooperation from the start, to abandon the Mir and bring the crew home. Not only is it not safe, they said (as if they were experts in complex space systems), but conditions will not permit the American astronauts to conduct the scientific research they were sent up there to do. Furthermore, the critics said, the Russians are just trying to take advantage of the goodwill of the United States, by saying the Mir is being kept operational to do science, when everyone knows its real purpose is to bring in hard currency to the Russian space industry from "guest cosmonaut" flights paid for by the West.

During a Mir status briefing at the Johnson Space Center on July 21, NASA's Shuttle/Mir program manager, Frank Culbertson, reminded the reporters present that doing science was never the priority for the Shuttle/Mir missions.

NASA's More Optimistic View

Culbertson said that when the Shuttle/Mir missions were announced, there were four priorities: first, for the United States and Russia to learn to work together in space, which is key to the future international space station; second, to perform risk mitigation, that is, to learn as much as possible on Mir about space stations, in order to reduce the risk on the international station; third, to conduct long-duration studies on humans; and fourth, to do scientific research, "when nothing is going wrong," as Culbertson put it. Recently, he said, as things have been going, "we are learning more than we had expected."

Culbertson and other NASA officials have repeatedly stressed that the experience that is gained with the Russians on Mir could well save lives when the much larger and more complex international space station is in orbit after the turn of the century. While no one would propose keeping a crew on board a spacecraft that is unsafe, the Mir has shown itself to be a remarkably robust spacecraft, with multiple pathways for dealing with accidents, and with the normal process of the aging of the station.



NASA

The Mir Space Station, as photographed from the approaching Space Shuttle Atlantis, on June 29, 1995.

At the same July 21 briefing, NASA's acting manager of the EVA project office, Greg Harbaugh, said that another benefit of having to deal with serious problems on Mir, is that it has required that the U.S. space agency be flexible in the Space Shuttle program, which will, after all, be the primary transportation for crews to the international space station.

Discussing the next Shuttle/Mir mission at the briefing, which is to deliver astronaut David Wolfe to the station, along with whatever material the Russians may request to help the crew repair the damaged Spektr module, a NASA shuttle manager said, "We are going to launch the Shuttle in September, but we don't know what we're going to do once we get there." Previously, each Shuttle mission was planned more than a year in advance, including every detail of the payload it would be carrying.

There are many reasons to try to repair the Mir and keep it operational as long as possible, until there is a better, newer, more capable facility to replace it. What is required from the U.S. side, aside from equipment, is the kind of "can-do" attitude that got our Apollo 13 crew back to Earth safely, and landed 12 Americans on the surface of the Moon.

—Marsha Freeman

ground testing that was permitted by the Ministry and the government.

So you end up saying to yourself, "Hey, the government, the Ministries, and the political leadership are not putting the money in there, so they're getting what they're asking for, as a result." But Mishin became the fall guy, and by 1974, when the doctrinal change in detente was beginning, the lunar program no longer had its place—as was the case geopolitically and in terms of policy in the United States. Mishin was relieved of his job in March 1974, fired, in effect, in a hostile corporate takeover, sanctioned by the Russian leadership. Quite brutal.

For a long time, Mishin has been very much criticized, and has been accused of being responsible for the failure of the lunar program. In reality, he was an exceptionally intelligent deputy General-Designer to Korolev. One reason that Mishin was not very popular, is that he tried to prevent others from working on their own hidden agendas, and to get all of them working on the assigned task.

Glushko continued to fight Korolev even after his death. He fought Mishin, looking over his shoulder. Roald Sagdeev, former head of the Russian Space Science Institute, has a lot to say about that in his book, *The Makings of a Soviet Scientist.* Glushko was an utter zealot, egoist, demagogue, and very destructive. He ultimately brought down Mishin and the lunar program. And he even went so far as to write the manned lunar program out of history, never acknowledging it—ignoring it, as if it didn't exist.

Soon after Glushko died in 1988, and when *perestroika* came along, guess what? Mishin began to talk about the lunar effort.

That's not all. As far back as 1981, I did a lot of publishing in the *Illustrated Encyclopedia of Space Technology.* One drawing that I did there is infamous with the Soviets, because it effectively showed N-1 and said to Glushko: "Ha, ha. You want to rewrite history, but this is what existed." That drawing was published in the Soviet newspapers *Pravda* and *Izvestia.* It's not a perfect drawing; it's not dead right, but it actually shows the N-1. It was close enough to shake them up, because the book was at a big British and American book show, held in Moscow once a year. All the chief designers, including Mishin and Glushko, went out and looked in this encyclopedia. "They declassified it!" It wasn't exactly right, but it really shook them up, no end.

Question: During the period of the Nixon/Brezhnev detente, the planning began for the joint 1975 Apollo/Soyuz mission. But before that, there was a decision by the Soviets, in the early 1970s, to develop a series of space stations, largely for military reasons. Didn't that become the focus of their manned activities?

The first Salyut station was launched in 1971. That decision was made in the fall of 1969, after the July 1969 launch failure.

Question: And of course, in 1969, the Americans landed on the Moon, so the race was over for all intents and purposes, because getting there second was like not getting there at all.

Right, and with a program that was not as good, with not as many people on the lunar surface.

Question: That's why I was surprised to see that, even after our lunar landing, the Soviets continued to test the N-1.

They continued to test it well after we had nearly finished flying Apollo. Starting in 1970, they committed 600 million additional rubles to the lunar program, over and above the appropriations level, which was a total of 4.5 billion rubles from 1960 through 1974. They were looking at an advanced lunar booster that would use hydrogen upper stages—a derivative N-1 design, that is in some of my illustrations. It was going to be used to create a lunar base, which could provide 30 to 120 days on the lunar surface. That would have been possible by 1980 or so, but the program was never committed.

If the Soviets had continued N-1 development, I doubt that the Shuttle would have ever completed development. That would have changed the entire direction of our space efforts, both Russian and U.S. I doubt that Saturn V would have totally gone out of production.

Question: Because we would have continued the lunar program?

The White House was very concerned about the continuing of the N-1 program. The Nixon White House knew about the fourth N-1 launch vehicle failure before the Kremlin did. I know that. The White House was clearly very concerned, because it would affect our space policy and what we were doing. The Air Force and other factions wanted to go to a Shuttle-class vehicle, which the aerospace industry wanted. Industry wasn't getting a lot of new, lucrative research and development contracts out of continuing Apollo. But if the Soviets had been able to launch their lunar program in the 1970s, we would have probably continued Apollo.

Question: What was most striking to you in your trip to Russia and the Baikonur Cosmodrome last April?

The trip was an eye-opener for me. It's the second one I've taken with the Friends and Partners in Space. The Baikonur Cosmodrome is being consolidated, and the older facilities, which are 40-plus years old, are being abandoned. There is a lot that is deteriorated; entire apartment complexes have been abandoned. But people are coming back to the Cosmodrome. You don't see much out-of-control military. Discipline is being maintained.

Two years ago, there was almost *no* activity inside the N-1/Energia and Buran assembly buildings, but now they're moving in commercial activity, and the Soyuz and future Rus booster. The Rus booster is a derivative of the Soyuz booster, called Soyuz-2, in fact. It is an improved, upgraded version of it that will be used in the space station.

They are refurbishing areas and consolidating into the newest and the best, which is the N-1/Energia/Buran facility. They have not gotten rid of the Buran orbiters, or the Energia boosters. There are two flight boosters available, although they need engines for the strap-on boosters. There are other ground-test elements associated with it there. They have a complete dynamic test tower. It's practically brand new. The N-1 facilities and the Energia facilities can eventually be refined to accommodate the Rus booster and possibly, Energia/Buran.

The Russians feel that nobody is going to abandon those vehicles totally, and not utilize them. They don't want to lose the capability, because they're looking toward the future and, I'm sure, not merely in Earth-orbit, but in lunar and planetary participation, way down the road, when their economy gets better. I respect that completely. Even the Russian Space Agency has tried to develop an all-new launch-vehicle family of improved vehicles, as well as new ones, utilizing old ICBMs or newer ICBMs for space boosters, instead of throwing them away. They are offering them both commercially and for their own military and civilian space programs.

I saw some of the other facilities, including hardware that you had never hoped to see in your lifetime, military rocketry hardware. I saw the competitor to Yangel's SS-9 ICBM, and Chelomie's UR200. I saw the R-26, which used to be one of the parade missiles, known as Sasin. I saw the R-7 ICBM, the old Sputnik booster. You could see it even inside—the details, and the guidance packages. We went to mission control. It was a beehive of activity.

We went to TsNIImash, the Central Specialized Design Bureau of the Institute of Machine Building. This is an awesome facility, which is roughly equivalent to the Tullahoma Air Force facility, Marshall Space Flight Center, Lewis Research Center, and more, combined in one place. It's unbelievable to look at this, how spread out it is, and what that facility does for their strategic as well as space programs. They do primarily dynamic acoustic, environmental, wind tunnel testing—full-scale testing. That's where all stages of the N-1 were tested, not only in a scaled version, but with full-sized hardware. Each stage was dynamically tested. They never dynamically tested the full stack, unless they did on the launch pad.

Question: What did you see of the N-1?

I saw N-1's interstage, between the first and second stage, in photographic form, undergoing dynamic testing. I also saw photographs. I wasn't able to see the model, but I saw two different versions of N-1's design—quarter-scale dynamic models, full-up vehicles—on which they did the dynamic testing. They were very confident in their dynamic testing techniques; they did not worry about doing a full stacked vehicle under dynamic testing, which we did with Saturn V.

Question: Did you see any N-1 hardware?

Yes, I did. I saw some of the interstage truss structures. I saw many of the kerosene tanks for the first, second, third, and fourth stages. I saw some additional structure where the six engines would sit on the engine boat-tail—the actual plate that sits there and is the end plate of the vehicle, where those six engines sit. I saw the erector transporter that was used, although it was revised to handle the Energia. I saw the launch pad at a distance, several thousand feet away. We were inside the N-1 assembly building, which is being used for Energia/Buran. As I said before, they are consolidating facilities in support of the space station, and are putting the Soyuz booster in there. They will be handling the Rus booster, and eventually, the N-1 pad is going to be handling the Rus booster, too. All the Soyuz pads and the assembly building are going to be shut down. It is fascinating that they are looking at the future and combining it all in one place.

Question: One major part of their activity today is commercial operations, and the other is the international space station, and, parallel to that, keeping the Mir operational as long as possible. How are the Russians positioned to carry out the space program they have going on now?

They're not in the best of shape; that's for sure. But they are systematically consolidating, in such a way as to be able to *definitely* support the international space station. The funding and the facilities will be ready for that. I saw a lot of feverish work going on to support that, at Baikonur as well as in Moscow, where work is being done on the Service Module. Proton launch vehicles are going to be available to launch various elements of the station. They have more than enough of those, and their commercial launches are being sold quite rapidly for Proton. They're selling the Proton booster like crazy, for commercial communication satellite launches and things of that kind.

The Soyuz booster is also going to be used for that. The development of the Rus booster will almost certainly be guaranteed because of that. So, Samara will get the advanced Soyuz booster and its Molinya derivatives with various upper stages.

The international space station work, the development and construction of the individual modules, is continuing. We saw that very clearly in Moscow, now that they are apparently resolving the appropriations problems, or at least prioritizing that. The Russian budget is actually falling, with tax collections some 45 percent short of the revenue needed for financing the entire government. But the space program is a protected budget. It will get at least as much as it got last year. With the consolidation going on that I've seen, I think they will be able—or are positioning themselves to be able—with the help of the commercial launches and the money they're earning from that, to accomplish what they say they are going to do. It's going to be tight, though, because some of the commercial activity is independent companies that are *not* paying the Russian government, but may be contributing to the programs.

There are some direct contracts that are being paid from the United States to the companies, which is really the only way to do things. Don't go through the Russian government to give appropriations, as the United States learned the hard way this last spring and fall, because that money might get diverted to something else and never get to the Russian Space Agency. That is literally what happened in relation to the Service Module, as I understand it, at least. Something has been done to address that issue and resolve it, and work is moving forward.

Question: What reflection of their heritage from the Soviet lunar program do you see in the way the Russians have tried to deal with the June 25 accident aboard the Mir space station?

In a lot of respects, we are very lucky that they had the accident on Mir recently, because of what we can learn in order to be ready for similar problems on the international space station. I feel reasonably sure the Russians are going to resolve that, solve it, and get it back on line.

Their tenacity is unbelievable. You fix it. That's what we do also, whether we want to admit it or not. And Mir is a major, major technological accomplishment on the part of the Russians. Credit needs to be given accordingly. Even their lunar program, which failed and was ultimately scrapped, has much to teach us, and was a major accomplishment.

Pathfinder Discovers a New Mars

by Marsha Freeman

Continued from back cover

Through the "eyes" and other scientific instruments on the Pathfinder lander and the diminutive rover, scientists are seeing yet another "new" Mars, one which will eventually reveal whether or not life developed there, and which will be an abode for human explorers who follow the robotic explorers that have led the way.

The Magnetic Phase of Mars

One of the indirect ways scientists will learn more about the history of liquid water on Mars, a prerequisite for life, is by understanding the magnetic properties of the soil and rocks on the planet. The element iron, which is the third most abundant element on Mars (after oxygen and silicon), reacts strongly with liquid water. The history of water on Mars is reflected in the iron mineralogy of the soil. The presence of different crystals of iron oxides, and the trace minerals such as titanium that have precipitated in the water, will help geologists understand how much water there was, at what time in the history of Mars.

JPL/CIT/NASA

A mosaic made with data from the Viking orbiter of the Mars Pathfinder landing site, Ares Vallis. The landing ellipse is 60 by 120 miles, and north is up; it is 527 miles from the Viking landing site in 1976.

The mosaic shows the large outflow channels that emptied into Chryse Planitia, as Ares Vallis flowed to the northwest from the southeast across the landing site. The channel formed from the release of water from the Martian subsurface and flowed across the surface, creating the channels and the large islands (just to the south and northeast of the landing ellipse).

Permanent magnets carried on the Viking landers were found to be saturated with magnetic soil from the very beginning of the mission. As a result, the Mars Pathfinder carries on it magnets of varying strengths, including weaker ones that should not saturate so quickly and should give a differentiated picture of the magnetic phase of the Martian soil and dust.

There are three different magnet experiments on Pathfinder: The Magnet Array Experiment consists of one block carrying two magnets of the strength used on Viking, and another carrying two weaker magnets. There are two different arrays at different heights on the lander, to attract salty sand grains on the lower, and wind-borne dust on the upper. The Imager on Mars Pathfinder (IMP) camera is transmitting images back to Earth of the dust particles that have accumulated on the magnets. These will provide the data on which conclusions about the magnetic phase of the Martian soil will be based.

Different iron oxides have differing magnetic properties, so by observing on which magnets the dust adheres, scientists will be able to determine some of the essential properties of the dust. It is hoped that it will be possible to identify the minerals responsible for what has been known to be the highly magnetized Martian soil.

A comparison between the magnet array on Sol 6 (Mars day 6 of the Pathfinder mission), and on Sol 13, shows an accumulation of dust on the two strongest magnets during that time. As more dust is attracted, scientists expect the pattern on the magnets to become clearer.

Mounted on the IMP camera itself, is the Tip Plate Magnet Experiment, which is one magnet embedded in magnesium metal. Because it is placed near the camera's eye, a high-resolution image will be possible, and scientists hope to be able to determine if the magnetic grains align in chains, or do not form chains, again giving them an insight into the particular iron oxide that has been captured.

The third experiment consists of a magnet at each end of the ramp used by the rover to exit the lander. At some point, the Sojourner rover will return to the ramp and place the sensor head of its Alpha Proton X-ray Spectrometer on the magnetic dust collected on the Ramp Magnet. The spectrum will be recorded and compared with the spectrum of the general Martian soil.

At a science briefing at the Jet Propulsion Laboratory on July 10, Dr. Jens Martin Knudsen from the Niels Bohr Institute for Astronomy in Copenhagen, reported that pictures of clear patterns on the lander magnets would emerge in the following weeks. From the preliminary results, it appears that although the particles on the different magnets vary somewhat, the magnetic mineral seems to be the same; it is the mineral used in the memories of computer discs, maghemite, or Fe_2O_3.

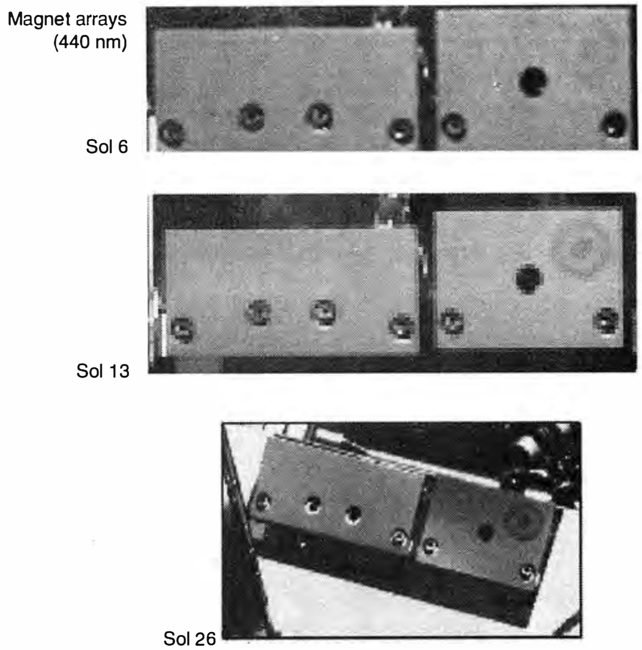
"No one knows how the soil on Mars formed," Knudsen said. "Is it an ongoing process today through the interaction with an oxidizing atmosphere and rock?" The results from his experiment, Knudsen said, will help us to understand the evolution of the soil. "Are only the air-borne portion of the particles magnetic?" he asked.

In response to questions from the press, Knudsen said that it would "not be easy to find a terrestrial soil as magnetic as the Martian soil. I don't understand how such a magnetic soil can be formed in such large amounts." The Pathfinder science team hopes to learn the answers during the mission.

Mars's Changing Rocks and Soils

One of the primary goals of the Pathfinder mission is to provide data to allow the quantitative analysis of the elemental composition of the variety of rocks and soils at the Ares Vallis flood plain. Scientists believe that many different kinds of rocks were washed down into the plain from the highlands. The Alph Proton X-ray Spectrometer (APXS) on the Sojourner rover has, so far, provided scientists with enough data to keep them busy for months, if not years.

These data have revealed at least five kinds of rocks and soil in the immediate vicinity of the lander. There are areas of drift that are pink in color, and most of the rocks are dark gray, and are less red in color than the drift.



THE MAGNETIC PROPERTIES EXPERIMENT

The permanent magnets in this experiment are assembled to produce a bull's-eye pattern of attracted dust. The magnets depicted at the top are of the lower magnet array on the Pathfinder lander on Sol 6, its sixth day on Mars. The strongest magnet, on the right, shows slight evidence of dust collected. The middle photograph, on Sol 13, shows a more pronounced pattern. The lower set of magnets are mounted higher up on the lander, and on Sol 26, show that more dust has been attracted to the magnet.

Source: NASA

The typical soil appears to consist of a mixture of drift and small dark gray particles resembling the rock, indicating the continuous soil-creating activity of the winds and weather on Mars. Some of the rocks, appear to have pinkish or white pebbles and crust, lacking the coloration associated with iron minerals. Scientists suppose that these rocks are less weathered than the redder ones.

The first target of the APXS on the diminutive spacecraft, was the rock Barnacle Bill, which was only a few feet from the lander. The second was the larger rock, Yogi, a bit farther away.

Barnacle Bill is typical of the unweathered smaller rocks at the landing site. Upon examination of the spectra the APXS sent back to Earth, scientists found that the chemical measurements mirrored what they could see in the photographs. Barnacle Bill has two basic kinds of spectra: one is soil-like deposits (its barnacle-like appearance), and the other is the dark rock face.

At the spatial resolution of 1 to 2 centimeters possible with Sojourner's instrument, the rock composition is homogeneous. But it may be composed of fine-grained materials, that cannot be seen with the APXS.

Yogi appears to have a weathered coating, but also exhibits a fresh face to the northeast. Scientists think that the planet-wide dust may be scouring that face of Yogi, or that pieces may be fracturing off to expose a fresher surface.

It is clear that the weather on Mars continues to change the face of the planet. The Pathfinder engineers and project scientists hope that both the lander and rover will continue to operate as the seasons on Mars change from summer to fall and then winter, over the next few months. In September, the Mars Global Surveyor will arrive at Mars, and will observe from orbit many of the same phenomena Pathfinder has been observing on the ground.

This multilayered view of the planet will continue to present a "new" Mars over the next year.

Fight for the Fast Breeder Takes Off in France

by Emmanuel Grenier

Even in France, the country with the highest share of nuclear electricity (80 percent), it is highly unusual to see a grassroots movement in defense of nuclear power. Nevertheless, that is what is going on around Creys-Malville, near Lyon, where the world's largest fast breeder reactor has been constructed.

Superphénix, as the reactor is named, has been at the center of a campaign deal made before the parliamentary elections in June 1997. In April, the Socialist Party and the Greens signed a joint agreement committing their parties to shut down two major infrastructure projects in France: the Rhine-Rhone canal and the Superphénix.

The canal is an important waterway between central Europe and the Mediterranean countries, whose construction had just begun. Now the project is completely stopped.

The Superphénix is a 1,200 MW fast breeder reactor, built jointly by French, Italian, German, and Belgian electricity utilities. After many initial problems, it operated excellently in 1996, reaching a 95 percent reliability rate. It is now condemned to death by the Red-Green coalition, for purely ideological motivations. On June 19, the new French Prime Minister, Lionel Jospin, announced before the National Assembly that he will close the plant.

The Committee to Save Superphénix is taking an aggressive approach to saving the world's largest fast breeder, breeder technology, and advanced technologies in general.

Historical Support for Nuclear

Until now, people working in the French nuclear industry felt somehow protected, unlike their colleagues in other countries. They relied on a general agreement existing in the country, for the continuation of a strong nuclear industry as a science driver. After World War II, General Charles de Gaulle created the Commissariat à l'Energie Atomique (Atomic Energy Commission), which led the national effort to master nuclear technology, both for military and civilian uses. It was then supported by all the political forces that emerged from the French Resistance movement, from the Gaullists to the Communist Party. In the 1970s, a massive construction effort led to the building of 54 nuclear plants, producing 75 percent of French electricity.

Over recent years, as the generation of nuclear pioneers has been progressively replaced, the situation has changed. "Baby-boomers," who have no experience of the fight necessary to implement a new technology, are now in command in the nuclear industry. Living under the umbrella of governmental support in the past, they never had to fight. This explains their failure in facing today's political situation, where the Greens were able to ambush the national infrastructure.

The shock of the Greens' success, however, provided a new awakening for the younger generation. These young nuclear engineers have joined with local entrepreneurs, residents, and elected officials in a "Committee to Save Superphénix," which is waging a peaceful guerrilla war against the Greens.

The employment of 3,000 persons depends on Superphénix, and the life of the Creys-Malville region is in great jeopardy if the plant is closed. Moreover, the fast breeder is only the first domino: After Superphénix, the plutonium recycling plant in La Hague (Normandy) will be threatened, and next, the nuclear industry as a whole.

For the past year, in fact, the La Hague plant has been subjected to constant attacks from the Green lobby. The antinuclear militants claim that a small cluster of leukemia cases in the region was caused by effluents from the plant. (This has been shown not to be true.) Greenpeace, which has vastly reduced its operations in France, has nevertheless dedicated a number of its irrational media shows to the La Hague plant, which it considers its highest priority in the country.

There is also an offensive going on, jointly led by free-marketeers and Greens, to make sure that the next electricity utilities built in France will use gas as their fuel. According to them, gas is the least costly way of producing electricity.

A Broad-based Fight

In this situation, the members of the Committee to Save Superphénix understand that they must now wage a fight at the highest level possible. In other words, they cannot be content simply with defending their own jobs, but must fight over the necessity of continuing the operation of the world's most advanced fast breeder, in the context of an increasing use of nuclear energy, especially in Asia (China, Korea, Iran, and so on).

The propaganda against the fast breeder has been so strong, and so pervasive, playing on the fear of plutonium and liquid sodium, that it is necessary here to remind American readers why France, Russia, Japan and India have planned and realized these kinds of nuclear plants.

First, recall the context of the 1970s. That was the time of the "oil crisis," manipulated by then U.S. Secretary of State Henry Kissinger and his friends. At the time, the Malthusian Club of Rome argued that there would be no more oil by the beginning of the 1990s. Hysteria reigned. In Belgium, it was forbidden to use a car on the weekend. In France, there was a maximum allowable temperature of 19°C (66°F) in apartments.

In this context, nuclear energy appeared as *the* logical solution, as an advanced technology that would overcome a shortage of energy resources. France then invested massively in this technology, but was not the only nation to do so. As a result, the question of the world's uranium resources came to the fore. Far from being inexhaustible, uranium resources are relatively limited: At today's rate of consumption, there are 60 years of uranium left.

Enter, the Breeder Reactor

Then came the idea of the breeder reactor, which "produces more fuel than it burns." Does this sound like magic? Let me explain: Imagine shipwrecked people on a desert island. It rains and everything is wet, except a tiny quantity of dry wood. They build a fire, but know it will not last long. One clever person thinks that, maybe, by putting some wet wood around the fire, it will dry out. They try that, and realize that you can dry more wet wood than you burn dry wood.

These shipwrecked people had just invented the "breeding" of wood. They can now consume all the wood on the island, not only the small amount that is dry.

This is exactly what goes on in a fast breeder. Here, the dry wood is the plutonium; the wet wood corresponds to natural uranium, which, submitted to the neutrons of fission reactions, is transformed into plutonium. To achieve this transformation, requires neutrons at high speed. Thus the word "fast" is associated with the breeder reactor.

The breeder functions like an amplifier of natural resources, because it increases by 100-fold the energy equivalent of the uranium reserves that can be produced in traditional light water nuclear reactors. This makes nuclear energy a renewable energy, whose fuel cost is relatively unimportant. In a fast breeder, the operating costs are mainly the salaries of the highly qualified men and women working on it.

Given this information, how is it the breeder has not met with success? The first reason is, of course, the worldwide

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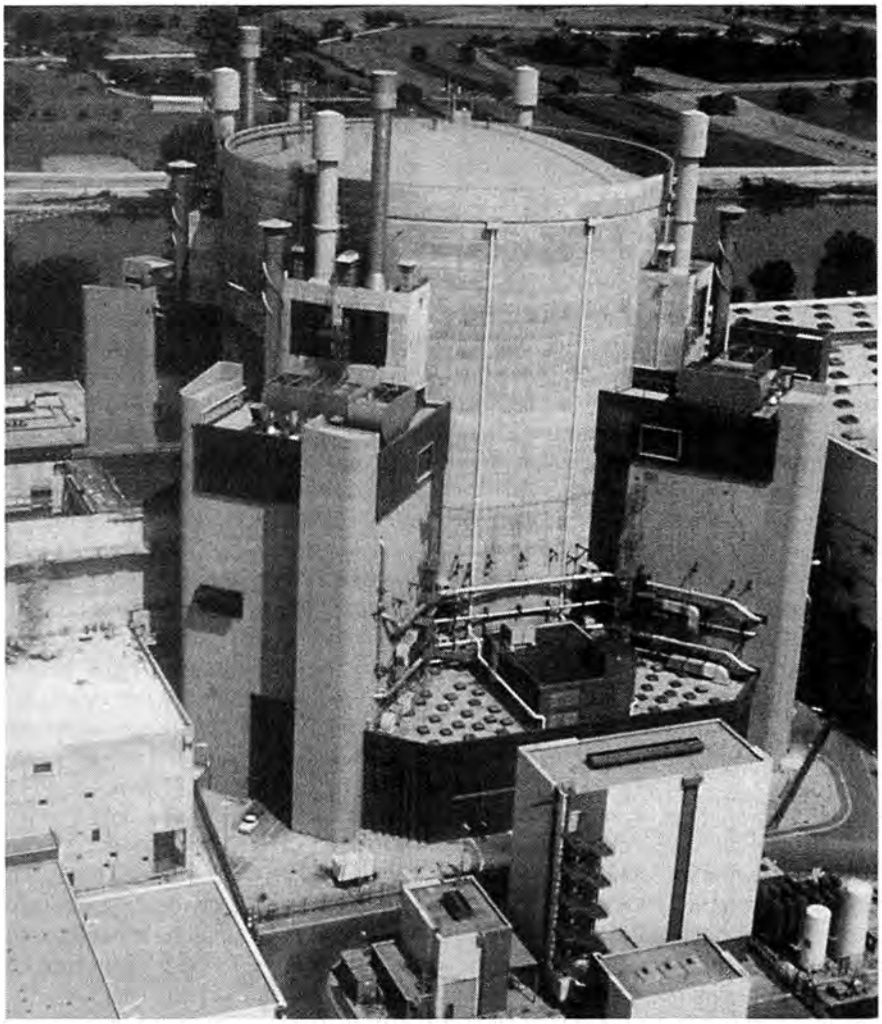

AEC

Superphénix, the 1,200 MW fast breeder reactor, built jointly by French, Italian, German, and Belgian electric utilities, now condemned to death by the Red-Green political coalition.

Letters

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world is a protein problem, not a carbohydrate problem. The world produces plenty of carbohydrates, but it is short of protein. That is a crucial problem.

As for feeding the world, it's a mistake for the United States to export any food. When food is exported, it's at the expense of the soil capital. In the cultivation of the soil there is a steady oxidation of the humus, which is the soil capital. In addition, each crop depletes some of the trace mineral reserve. It is said that a soil is good for 100 years, or 100 crops, because by that time, the trace minerals are taken out of the soil, the food quality goes down, and the trace minerals are not replaced by our modern fertilizers. . . .

Harold N. Simpson, Biochemist
Chicago, Ill.

The Editor Replies

The Special Report in the Summer 1997 issue makes the point that the Earth has the potential for food output for billions more people, and this is strictly a policy question. "Natural resources" for agriculture—soils, water, temperature, and so forth—can be "man-made."

From this vantage point, we differ with your outlook in several respects. First, the world is not producing "plenty of carbohydrates," as you claim. The reality is that world food supplies are deficient in all respects—whether calories or proteins and other nutrients. In North Korea, 24 million people are in famine conditions; similarly, there are severe shortages in Central Africa. Food relief can and should be mobilized urgently.

There is a worsening food crisis in the world today: an insufficiency of food output and supplies (including storage and handling); an insufficiency of production *potential* (because of lack of infrastructure, maintenance of soil fertility, underpayment of farmers, and so on); and the use of food control as a weapon.

Bad policies have created this situation; there is *not* a lack of science in agriculture and biochemistry that could be applied. And it is *not* true that the physical resource base for agriculture has been exhausted—which is the oft-heard lie that Lester Brown, of World-watch Institute, is paid to promote.

We do not disagree with some of the other issues you raise, but we recommend that you look at the policies that caused the problems. For example, soil fertility. Yes, soils in many farm belts, are degrading from lack of proper fertilization practices (including trace as well as bulk minerals). Likewise, basic grains have shown a decline in protein content in recent decades.

These, and similar conditions, are all associated with the takeover of national food and farm policies by cartels of private commodity interests and their interconnected financial circles.

Look at the policy crisis, in the case of another country, the dramatic example of Russia. There, the recent years of IMF free-trade "reforms" have driven food production down so far (way below even the levels of the Soviet command-economy system), that malnourishment and disease are rampant. Last year, only an average of 12 kg of fertilizers were applied per hectare, compared to 99 kg/ha, on average, in the years between 1986 and 1990. The Russian Research and Project Institute for Agriculture Chemistry reports that the losses caused by this, amount to 90 million tons of grain equivalent per year.

Last year, only 28 percent of grain area planted was fertilized at all; this year it will go down to even 15 percent. Depletion of the soil is 4.5 times greater than the input of fertilizer.

Another Scientist Speaks Out on the Non-Science Of Global Warming

In the Summer 1997 letters column, we printed several letters from around the world sent to Dr. Robert Stevenson in response to his article "An Oceanographer Looks at the Non-Science of Global Warming," which appeared in the Winter 1996-1997 issue of 21st Century. *Here is another letter, provided to us by Dr. Stevenson. It is from a scientist and university professor in a former Soviet nation, whose name has been withheld.*

Several months ago, I received your *21st Century* article. I wanted to answer you quickly, but the problem you were discussing was too important, and could not be solved on the spot. As a member of [one of the United Nations international environmental panels], I read your paper very attentively.

You are absolutely right in your protest against dishonorable science, but I don't think it is easy to differentiate dishonorable scientists from among others. I am sure that most of the scientists are sincere in their aims, and only time and results of investigations can show whether those aims were true or wrong.

In my recent practice, I had a similar situation. We were preparing the science plan [for one of the U.N. environmental programs], and a responsible person for the program asked me not to insist on some points and corrections (although he agreed with them), because otherwise the Japanese would not give money for some of the joint work. I was astonished and said that we made the plan for scientists, not for politicians. Maybe, I said, politicians would give money, but scientists would not join the plan if it would not be scientifically argued and formulated. . . .

I see another aspect of the problem also. True science is not needed now in our society of "global" consumption. To preserve themselves and the possibility for research, scientists often have to adjust to the consumption requirements in two ways: (1) to pretend to solve the "consumption" problem, but to use a large part of the money for fundamental science; (2) to frighten people and governments by sounding the alarm around some problem. . . .

To illustrate my point, let's take the example of [former Soviet state] scientists. My salary is a little more than $200 per month, and my subordinates get two to three times less. To continue our scientific work, we have to earn money in any possible way. As for me, I can do it with the help of my car, sometimes acting as a taxi driver . . . but my subordinates don't have such a possibility. And you understand that we are ready to investigate any problem, provided it will be paid enough to support our life and normal work.

Of course, this [country] is now an extreme example, but in principle, the situation is the same in all countries. Maybe we are too good for our time?

Remembering Clyde Tombaugh

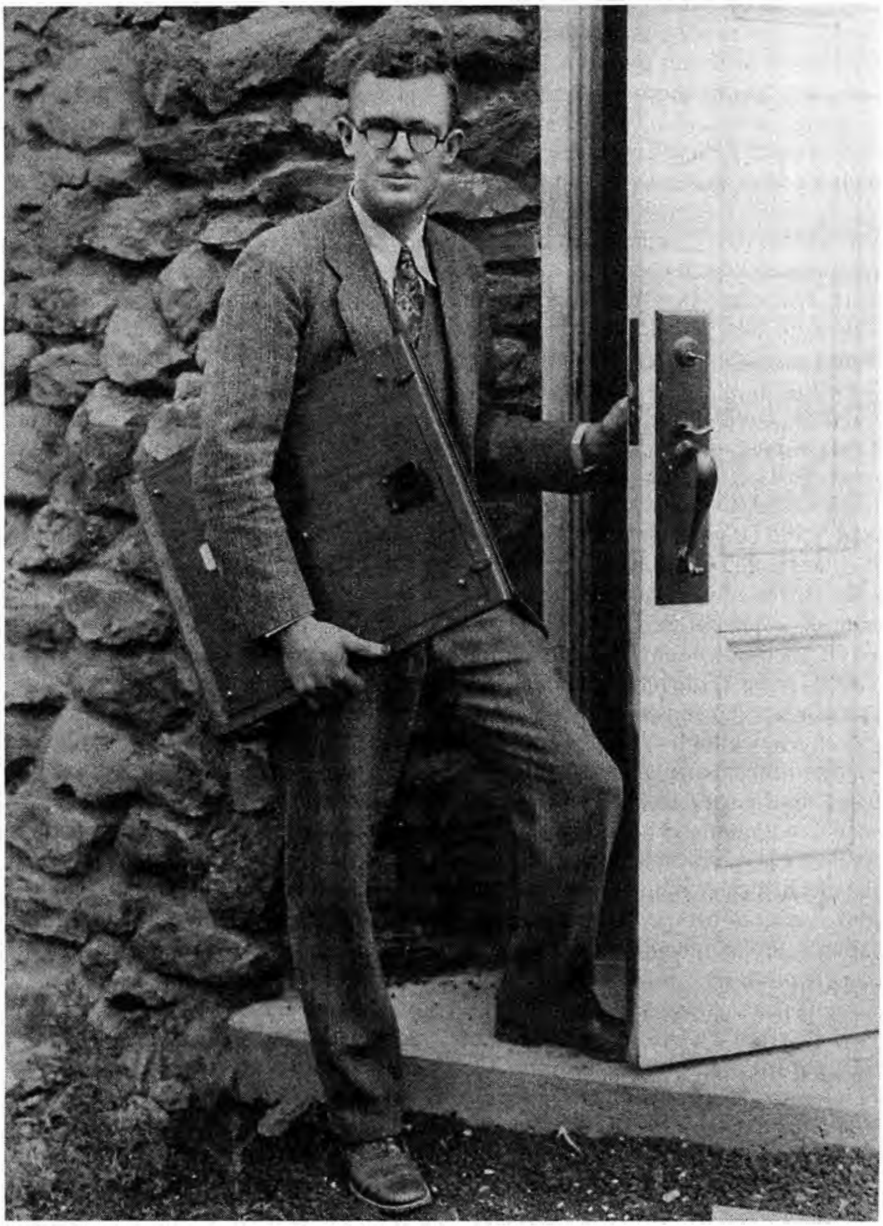
by Dr. Charles Osterberg

Astronomer Clyde Tombaugh's recent death was widely reported, and he was described as "truly one of the great men of science." Strange. His discovery of the planet Pluto wasn't even included in my trusty set of *World Books,* which seemed to give astronomer Percival Lowell all of the credit.

I worked at Lowell Observatory from 1946 through early 1949, helping Dr. Earl Slipher, who was studying and photographing the planets, mostly the inner planets—Mars, Venus, Saturn, and Jupiter—and occasionally, Mercury. Pluto had been discovered long before, in 1930. I never worked at Lowell when Tombaugh was on the staff, but I was familiar with his work. On one of my first days at Lowell, as part of my education, one of the astronomers had set the paired photos (one of the sky before Pluto arrived on the scene, and one after) in which Pluto was discovered, on the blink comparator and let me see Pluto hopping back and forth. The astronomer explained how these two photos (actually glass negatives, 14 by 17 inches) were handled by the optical machine—a primitive machine by today's standards.

The blink comparator looks at one negative, then the other. Stars don't have much proper motion, so slides taken a few nights (or months) apart show no motion for stars. That is, you can overlay one plate on the other and look through it, and everything will be the same on each plate. But an asteroid may zip a long distance on the film in that period, as would some comets. As for a new planet, it would be a much more modest jump from one night's position to one a few nights later.

Wonderful. If I have a planet or an asteroid or a comet, it will blow its cover by jumping back and forth in the blink comparator. So all you had to do was scrutinize all parts of the plate, and if nothing was jumping, you didn't find your planet, or whatever.



Courtesy of Lowell Observatory

Clyde Tombaugh 1906-1997

Tombaugh, who discovered the ninth planet, Pluto, in 1930, died on Jan. 17, 1997. He is pictured here at the entry to the "Pluto Telescope," carrying a plateholder for the type of large glass negatives that were used in the discovery of Pluto.

But don't despair. It never happens that way. Every dust speck, unless there is one exactly placed on the other plate, will hop around too, giving you quite a thrill until you figure out that it's only dust.

And believe me (and Clyde Tombaugh), there are lots more dust spots than all of the planets and asteroids put together, more than all of the stars in the galaxy. I'm a bit sorry to have thrown comets into this mix, because comets look different—just hazy patches, sometimes with an even fuzzier tail, rather than a good solid blip, like a dust particle or planet.

A Passion for Pluto

Tombaugh, fresh off a Kansas farm, knew nothing about blink comparators (I think ours was a Zeiss, made in Germany), but you can bet your hide he knew lots about them after spending countless hours looking at new plates as he shot them. It must have been tough to keep the faith, that there was actually a planet up there somewhere waiting for him to discover, and what boredom there was looking at every piece of every plate. And when I used the machine, it was quite easy to rest your head and close your eyes; then the gentle jumping of the machine, chasing dust spots back and forth, could easily put you to sleep. It was a mechanical device, not electronic, so it gave a lulling meshing sound as it worked. Clyde was of sterner stuff than I, and stayed awake and pursued the plates with a passion.

But it was all Percival Lowell's idea. I can still remember the quote from Lowell on his mausoleum—or was it on a plaque on the 17-inch telescope? Lowell had written, "It means a planet out there, still undiscovered by man." And if that isn't enough, there is the mechanical computer he used to predict the presence of a planet and its probable location in the sky. Now talk about primitive, that mechanical computer wouldn't fit in your pocket or even on your desk. You had to be a math major to use that one. Lowell qualified; he was fresh from teaching math at Harvard.

A. Lawrence Lowell, president of Harvard for many years, had the 17-inch telescope specifically designed for the Pluto search, and gave it to the observatory. Without it, Clyde would have been severely handicapped; the new telescope could plot more of the sky than any other instrument available to Clyde.

Clyde Tombaugh came to Lowell Observatory on a visit, where I met him. He invited most of the staff over to the air base near Las Cruces, New Mexico, to see the launch of the last of the captured German V-2 rockets, used to bomb London in the last part of the war. Then, after it went up, they fired one of the first American-made rockets. It too went up, but was not nearly as impressive as the much larger V-2. Tombaugh was in charge of optical tracking at the launching site, so he showed us all of this equipment. Then, after looking at and talking telescopes (and rockets) all day long, after supper at his house, he took us out into his backyard, where he had a rather large telescope and dome set up for his own enjoyment.

I came away from my years at Lowell and my small amount of time with Tombaugh convinced that if he hadn't found the planet Pluto in 1930, it wouldn't have been found for a long time, as that work was truly tedious and it took a believer to keep after it. Clyde didn't get enough credit. They even named the planet Pluto, with its symbol PL, in honor of Percival Lowell. He and Clyde made quite a team. Both extremely persistent, Percival very cerebral and Clyde, perfect for the job, a dedicated Kansas farm boy, determined to earn his place in history. My negligent *World Book* overlooked a worthy discoverer.

Life on Mars

My few years working at Lowell Observatory were an experience I couldn't buy anywhere. For example, Lowell had written *Life on Other Worlds,* and was a believer, as were his closest followers. Not just "life on Mars," but intelligent life, capable of modifying the surface of a planet enough that the three senior astronomers on the staff could see changes in the canals through the telescope. They nearly convinced me, but I couldn't see what they were seeing and couldn't quite take that last big jump and join them. Fortunately, none of the old-guard astronomers lived to see NASA destroy their dreams and beliefs.

Dr. Seymour Hess was a young man at the observatory. Seymour had just completed his Ph.D. on the meteorology of Mars at the University of Chicago. I helped him with the brainless, tedious stuff. Dr. Earl had taken most of the plates of Mars with what he considered the best telescope in the world, our 24-inch refractor, built by Alvan Clark. Most of the other pictures of Mars used in Hess's thesis had been taken with a borrowed telescope in South Africa, when Mars was in close to the Earth, but in southern skies. I'd use a planimeter to measure the area of the polar ice cap (more likely frozen CO_2 than ice) on Mars, and Seymour related a bunch of the visible changes to circulation, dust storms, and cloud masses that occasionally blotted out the planet's surface details—the meteorology of Mars.

My job at Lowell was to develop photos and help out where I could. Since I liked the job (while going to college too) and wanted to keep it, I made myself as useful as I could. One thing I did was to learn how to set the right ascension and declination so I could have the telescope already set on Mars (or whatever Dr. Earl was working on) when he returned after supper. One night I had the telescope set on Mars, awaiting the boss. Seymour and I had been taking turns looking through it, and commenting on how little we could see, when Dr. Earl showed up. "How's the seeing?" was his first question. Seymour and I allowed as it looked pretty good—at least Mars wasn't hopping up and down because of turbulence.

Dr. Earl (I call him by his first name because his older brother, Dr. Vesto, also worked at Lowell) looked for maybe 30 seconds without comment, and then he enthused, "Oh, something remarkable has been going on down south of the Syrtis Major. That certainly has changed from last year. Remarkable." Naturally, Seymour and I had to take a look at this remarkable development. Nothing. Mars was about the same size and color as the red eraser on my pencil, and with about equal detail. Seymour and I compared notes later, and we were convinced that Dr. Earl was putting us on.

Then Dr. Lampland came in, stomping in the cold. "How's the seeing?" (If you want to be an astronomer, that seems to be the question to ask.) "Intermittent, good, and bad," said Earl, "take a look."

Dr. Lampland studied Mars for about 30 seconds, and then, in a voice ringing with elation, said: "Look at what is going on south of the Syrtis Major. That is so different from last year."

Seymour and I assumed the two old guys (both in their late 60s or 70s) were setting us up. But we gamely asked for another look, and, sure enough, there was the red eraser of my pencil, just as before.

The next day I went into Dr. Earl's office, and, since he didn't appear too busy, I confessed that I couldn't see anything through the telescope the previous night, at least nothing that looked like the globes of Mars with canals and stuff in our display cases.

Dr. Earl smiled sympathetically, and asked gently, "Did you ride a bicycle the first time you tried?"

"No, sir, it took a few tries."

"Yet, you expect to see canals on Mars on your first try?"

"Yes sir. I've been seeing and looking at things all my life. Why shouldn't that include canals on Mars? I didn't see any, and I have real good eyes. I was a sharpshooter in the army. Besides, I've been reading and, theoretically at least, you shouldn't see them even if they are there because they are so thin."

Dr. Earl walked me to the back door of the building and pointed over at Mt. Elden, about 10 miles away. Can you see that cable coming down from the top of that tower?" And he pointed toward the top of Mt. Elden.

"No, sir." I could barely make out the tower.

"I can see it in the telescope, even though, like the canals, it is too thin to be seen *theoretically,*" and he accented that last word. "We spent a lot of time here looking at cables and wires like that through our telescopes, and extended images like a cable or a canal can be seen when you would say they shouldn't be. Lowell's eyes were especially sharp."


Author Charles Osterberg

Then he chuckled. "There are lots of astronomers who don't believe in canals on Mars. Old Professor . . . from Wilson Observatory didn't, but he came here once, and, seeing them, he now believes. Charles, the only people who believe in canals on Mars are those of us who have seen them. If you train yourself to see, to really see, I think you will become a believer too."

But I never did, and I don't think Seymour did either. But I will say that those older astronomers could discuss changes in the planet that indicated they were both describing the same phenomenon, whatever it was. It must have been telepathy; that's what Seymour and I believed.

Charles Osterberg, who retired from the Department of Energy in 1985, graduated from Northern Arizona University, taught high school biology, and then received a Ph.D. in oceanography from Oregon State University. He became involved in gamma-ray spectrometry of the oceans in the late 1950s, working at the Atomic Energy Commission laboratory, for the DOE, and at the International Atomic Energy Agency's international laboratory of marine radioactivity in Monaco.

Osterberg is a member of the board of the Society for Environmental Truth, and this article is adapted from his column in the March-April 1997 newsletter of the society, The Torch.

Environment

Continued from page 81

breakdown of the nuclear industry. The number of reactors built was much smaller than predicted; uranium was not in demand. In fact, uranium prices went down when post-Soviet Russia dumped its enriched uranium on the world market.

Second, the Greens concentrated all their forces against the breeder, which appeared to them as the "lead duck": If they could stop the breeder, they thought, they would stop the rest of the nuclear industry. The Greens succeeded first in the United States, during the Carter administration, then in Germany, and now in France.

The Long-term Perspective

In a situation where policy-makers are thinking on a very short-term basis, and where very specific conditions permitted gas plants to be competitive, energy leaders came to look upon breeder reactors as useless. This is the same kind of linear reasoning that led bankers to plunge into real estate speculation, with results that are obvious.

The situation today presents the artificial view that there is as large a uranium reserve as is wanted. But this is untrue. The Greens revel in pedantic propaganda about "future generations." Let's take them at their word, and see what the perspective will be for the grandchildren of today's decision-makers, some 50 years from now. (The reasoning here is from a European standpoint but it remains more or less true for other developed countries.)

In 50 years, North Sea gas will be completely exhausted. Uranium prices will have increased greatly, making nuclear power hardly competitive. As for oil, it may be necessary to wage "bloody little wars"—like the one Margaret Thatcher, François Mitterrand, and George Bush waged against Iraq—in order to make sure that the nations possessing the greatest oil reserves behave.

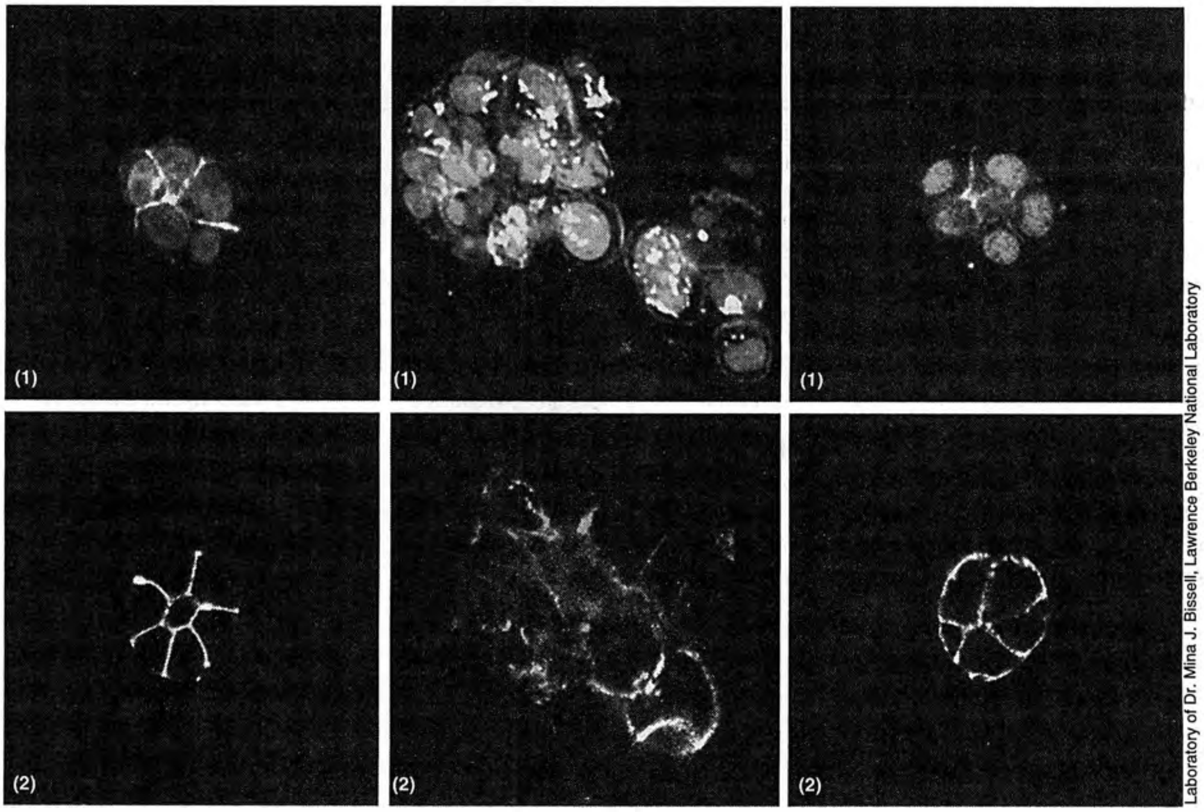
Of course, there is nuclear fusion. But with the freezing of the budgets for the International Tokamak Experimental Reactor (ITER), and the U.S. fusion program, the realization of advanced fusion technologies will be pushed far to the future.

What is left? Renewable energies? These do not permit sustaining the needs of modern industrialized societies, with an acceptable economic and environmental cost. Therefore, in the long term, the fast breeder is absolutely necessary. For this reason, the fight to defend Superphénix is not a fight to defend nuclear energy per se, but one for the continuation of the fast breeder option, and the continued introduction of more advanced technologies.

Emmanuel Grenier is the editor of the French-language magazine Fusion, *and the newsletter* Industry and Environment.

Intact Tissue Structure Acts As Tumor Suppressor in Breast Cancer

by Colin Lowry



NORMAL, MALIGNANT, AND REVERTED BREAST EPITHELIAL CELLS

This confocal fluorescence microscopy shows how normal tissue architecture acts to suppress malignant cells. The normal cells are at left, the malignant cells in the center, and the treated cells at right.

Left (1): normal cell colony (S-1 cells) with nuclear stain (gray) and actin filaments (white). (2): normal cell colony showing localization of cadherins and catenins at cell-cell junctions.

Center (1): Malignant colony (T4-2 cells) with nuclear stain and actin filament stain. (2): Malignant colony stained for cadherin and catenins.

Right (1): Reverted T4-2 colony after treatment with Beta 1 integrin antibody, with nuclear and actin staining. (2): Reverted colony stained for cadherins and catenins. The reverted cells show cell-cell adhesions, actin filaments, and cell shape similar to the normal cells at left.

Most research on cancer assumes that genetic mutations determine whether a cell becomes malignant. This is part of the dogma that the genetic content (genotype) determines the phenotype, or behavior of a cell. Recent breast cancer experiments have challenged this view, and offer another approach to treating breast cancer that uses intact tissue structure to eliminate malignancy.

The breast cancer experiments at Lawrence Berkeley National Laboratory, described here, have shown that the restoration of signals from the normal tissue environment can cause malignant cells to revert back to a normal phenotype. These experiments demonstrate that cells that would otherwise become malignant, because of the presence of genetic mutations, behave as normal cells—as long as the normal tissue architecture is maintained. The signals from the extracellular matrix of the tissue override the cancerous genotype.

This work challenges the basic assumptions about the development of cancer, and has prompted scientists to investigate the importance of the tissue environment in determining the phenotype of individual cells.

Cells in a tissue are signalled to grow or to differentiate to carry out a specific function by cues in the extracellular environment that are received at the membrane by a variety of receptors. In this way, the behavior of an individual cell is regulated at the level of the tissue.

Integrins are a family of protein receptors that mediate interactions between the cell and the extracellular matrix. The integrins are composed of two subunits, one alpha joined to one beta. There are 8 beta and 15 alpha subunits that can combine to form 21 different receptors, each with a distinct binding specificity. These receptors span across the membrane, and have a cytoplasmic tail inside the cell and an extracellular domain on the surface that can bind to various proteins.

Individual integrins are involved in cell adhesion, and may receive signals from the extracellular matrix (ECM) that stimulate cell migration, growth or differentiation. On the cytoplasmic side, the integrins interact with proteins associated with the cytoskeleton through their tail. The signal received at the surface is transmitted through the cytoskeleton in order to alter the cell structure, which may directly transmit the signal to the nucleus. Integrins also interact with important regulatory enzymes called kinases, which are involved in determining how a signal is amplified or processed in the cell. Although the various integrin receptors are involved in different functions, they all generate very similar signals at their cytoplasmic domains, so the processing of the signal by the cell determines the final response.

Tumor cells undergo several changes in order to metastasize throughout the body. First, the tumor cell must alter its adhesion to the extracellular matrix so as to detach from the original site. Then, it needs to migrate and penetrate through the adjacent ECM to get into the blood vessels. Because integrins mediate stable adhesion within tissues, and provide signals which arrest the growth of differentiated cells, malignant tumor cells alter the expression and localization of integrins on their cell surface.

As breast cancer develops, the normal tissue architecture is disrupted; tumor cells lose their cell-cell junctions, along with the polarized cell shape characteristic of the differentiated epithelial tissue.

The Berkeley Experiments

Scientists working in the laboratory of Dr. Mina J. Bissell, at Berkeley National Laboratory in California, have been investigating integrin-mediated signalling in breast cancer. Their initial experiments involved characterizing the differences in growth and behavior between malignant and normal cells in three-dimensional culture, which was developed in order to mimic the process that occurs in the developing breast. Instead of culturing the cells on a flat surface in one layer, the cells are dispersed within a mixture of proteins normally present in the extracellular matrix, that constitute a basement membrane. The ECM material provides the cultured cells with the correct signals for differentiation into a normal polarized epithelial tissue. The cells then have a three-dimensional environment in which to migrate and grow in this culture system.

The two epithelial cell lines used were from a breast sample of a nonmalignant lesion, with the malignant cell line the result of a spontaneous genetic mutation. When grown in simple two-dimensional culture, both the malignant and the normal cells had similar growth rates, and failed to undergo differentiation. However, when grown in three-dimensional culture within a basement membrane, the two cell types displayed very different behaviors.

The normal cells migrated together to form a spheroidal structure, called an acinar structure, similar to that found in the secretory epithelial cells in the breast. They underwent differentiation, and the shape of the cells became polarized. The cells also secreted the ECM proteins laminin and collagen IV on the basal side, contributing to an organized basement membrane. To examine the internal architecture of the cells, fluorescently tagged antibodies reactive to proteins that make up the filaments of the cytoskeleton, were introduced into the cells and viewed under the microscope.

The normal cells (called S-1) displayed an organized actin filament cytoskeleton associated with adherens junctions at the membrane-ECM interface, as well as cell-cell junctions containing the normal cadherin receptor complexed with catenin proteins. The cadherins are another class of membrane receptor proteins that are involved in cell-cell adhesion, which require catenins complexed on the cytoplasmic side in order to make stable junctions. Once the S-1 cells differentiated, they became growth-arrested and dropped out of the cell cycle.

The malignant cells (called T4-2) did not form normal acinar structures, and instead formed large, disorganized colonies of rapidly growing cells, which failed to differentiate. The T4-2 cells did not secrete an organized basement membrane, and their actin cytoskeleton consisted of random bundles of filaments. Also, cell-cell junctions were disorganized, with a loss of cadherin-catenin complexes, as well as the loss of functional adherens junctions with the ECM.

The expression and localization of integrins were found to be completely different between the S-1 and T4-2 cells. The normal S-1 cells had basally distributed beta 1, beta 4, and alpha 6 integrins, and basolateral alpha 3 integrin expressed on the cell surface. In contrast, the T4-2 cells had these integrins randomly distributed along the cell surface, as well as some integrins improperly localized in the cytoplasm. Also, the T4-2 cells overexpressed beta 1 integrin, while underexpressing beta 4 integrin, increasing the ratio of beta 1 to beta 4 on the surface by almost threefold.

Was the malignant behavior of the T4-2 cells linked to the changes in the expression of the integrins? If so, could the restoration of correct integrin signalling from the ECM cause the T4-2 cells to revert back to a normal phenotype? The next set of experiments tested this hypothesis. Using an antibody that inhibits the binding function of the beta 1 integrin, the two cell types were treated with this antibody, and grown in three-dimensional culture in a basement membrane. The normal S-1 cells reacted to the beta 1 integrin-blocking antibody by undergoing massive programmed cell death (apoptosis).

In many differentiated cells, contact signalling from the ECM is required for maintenance, and the disruption of the signal usually causes the cell to undergo apoptosis. In the lactating breast, after weaning has ended, the ECM is broken down by proteases, which leads to disrupted integrin signalling, followed by cell death in the secreting tissue.

The T4-2 cells did not undergo apoptosis in response to the beta 1 integrin-blocking antibody. Instead, these cells assumed a morphology like that of the untreated S-1 cells, and after 12 days in culture, had formed acinar structures composed of polarized differentiated cells. Amazingly, the T4-2 cells had reverted back to a nonmalignant phenotype! The reverted cells had normal actin cytoskeleton organization, cadherin and catenin localized with functional cell-cell junctions, and the establishment of adherens junctions with the ECM. The cells organized into acini also were able to basally deposit laminin and collagen IV onto the basement membrane, as did the S-1 cell acini.

To see if the reversion was permanent, or the result of changes in signalling from the culture environment, the reverted T4-2 cells were collected and re-cultured in the absence of the beta 1 integrin-blocking antibody. Without the antibody treatment, the T4-2 cells returned to their malignant phenotype.

After showing that the T4-2 cells could be reverted to a normal phenotype in culture, the scientists implanted antibody treated T4-2 cells into mice to see if the cells would remain nonmalignant in a natural tissue environment. Interestingly, the reverted T4-2 cells had reduced tumor potential in mice as compared to untreated cells.

Tissue Signals Determine Phenotype

The reversion of the malignant T4-2 cells to a near normal phenotype by blocking beta 1 integrin function is a startling result, considering that these cells have genetic mutations in several growth-control genes. This indicates that the tissue architecture of the ECM dictates the phenotype of the residing cells, overriding the genotype, as long as the cell-surface signalling network is able to receive the proper signal. The results of these experiments emphasize that integrins are part of a large integrated signal network involving the cytoskeleton, the membrane, and the nucleus.

Previous experiments by other scientists give us insight into the dynamic relationship cells have with the extracellular environment. A critical experiment done by Propper and Gomot in 1973, tested whether developing cells could be programmed to differentiate into specific types by the extracellular matrix of a tissue. The researchers took embryonic chick epidermal cells, and inserted them into the mammary stroma of a rabbit, which had the rabbit epithelial cells removed. The chick epidermal cells were directed by the ECM of the rabbit tissue to differentiate into mammary epithelial cells, reconstituting the ducts and structure of the normal mammary gland.

Differentiation of a cell requires changes in gene expression and regulation, which is directly influenced by the interaction of receptor signalling at the membrane. Another example of the effect of ECM-receptor signalling on gene expression is the case of the secretion of milk proteins by mammary cells. Mammary cells respond to hormonal signals that induce the activation and expression of genes for milk proteins only if they are in contact with the basement membrane.

While it is clear that signals coming from the ECM through integrin receptors play a role in gene regulation, the exact mechanisms by which it carries out this function is partly unknown. The cytoskeleton seems to be an important member in signal transduction and gene regulation. Experiments mechanically altering cell shape have shown that changes in the filament networks inside the cell can directly influence gene expression. Inside the cell nucleus, areas of chromosomes that are active are often attached to the protein matrix that is connected to the nuclear membrane. The intermediate filament network of the cytoskeleton has been shown to interact with the proteins of the nuclear membrane. Changes in cell shape, or stress on the cytoskeleton may induce changes in the nuclear matrix, which can directly affect the activity of chromosome areas interacting with the matrix.

Integrin receptors that are activated by binding to proteins in the ECM, form a complex on the cytoplasmic side with many proteins that interact with the cytoskeleton. The tail domain of beta 1 integrin can bind to the proteins tensin, alpha actinin, and talin, which bind to and organize actin filaments. For stable adhesion to the ECM, the cytoskeleton must be organized locally to the adhesion site. The change in one area of the cytoskeleton affects the overall structure within the cell.

Integrins also recruit kinases and phosphatases to propagate a signal within the cell. For example, beta 1 integrin can activate focal adhesion kinase which can phosphorylate other proteins and enzymes, changing their conformation and activating or de-activating their function. However, integrin signalling is coordinated with many other signalling receptors, such as the cadherins, and the cell interprets these signals as a whole, before determining a response.

Tissue Structure as Tumor Suppressor

Experiments done by scientists in Mina Bissell's lab in 1990, injected active oncogenes into chick embryo cells, to see if normal tissue structure could suppress the development of malignancy. These cells were identified by molecular markers, and appeared as normal cells in well-formed tissues. When these cells were removed from the embryos at a later stage, and placed in culture, they rapidly transformed into a malignant phenotype.

The research on the role of signalling from the ECM through membrane receptors presents a challenge to the view that genotype primarily determines the phenotype of a cell. The experimental evidence presented here shows that the tissue architecture, and the signals from the ECM, determine the phenotype of cells. It may be that an intact tissue structure is the most powerful tumor suppressor of all. These studies have shown the importance of looking at the interaction between a cell and its tissue environment, in designing approaches to treating cancer.

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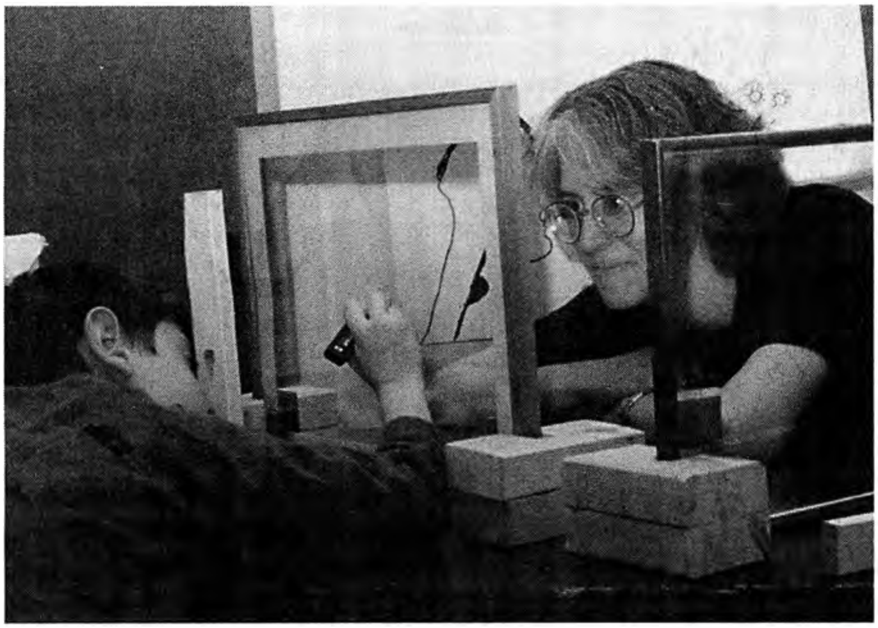
LEONARDO FOR YOUNG SCIENTISTS

Light: 'That Which Most Elevates the Mind'

by Susan Welsh



EIRNS/Susan Welsh

At a party celebrating Leonardo's 545th birthday, participants test out the vertical glass pane. It is made with empty picture frames, propped up on either side by blocks of wood. The eye of the viewer must remain stationary; he looks through a peephole that has been drilled through a narrow piece of wood, which is attached to a wooden stand. The student draws directly on the glass with an erasable marker.

The first part of this series (Summer 1997, p. 81) introduced the work of the Leonardo da Vinci Science Club in Leesburg, Virginia, which conducted weekly classes from October 1996 through April 1997. The students were six- and seven-year-olds. Part 1 dealt mainly with geometry; Part 2 takes up another of Leonardo's favorite subjects, optics and the science of perspective.

Among all the studies of nature, Leonardo da Vinci wrote, "light chiefly delights the observer" and "elevates the mind of the investigator."

Why did he think that?

One could imagine many reasons. The most obvious, is light's beauty. Not just its natural beauty, but the higher beauty which the artist creates, when he uses light in a painting to illuminate the human soul and to convey a conception of the Divine. The precious few paintings by Leonardo that have come down to us, give abundant evidence of that.

Another reason, is the very devilish way that light behaves. How can we know truth? Through our senses, as the empiricists say? Not at all! Any child who has "turned the world upside down" with a *camera obscura,* or has observed how an oar looks bent when it enters the surface of a stream, can tell you that our eyes play many tricks on us. Like the prisoners chained in the cave in Plato's *The Republic,* we see only shadows on the wall; what "reality" is, is something for the mind to determine—not the senses alone.

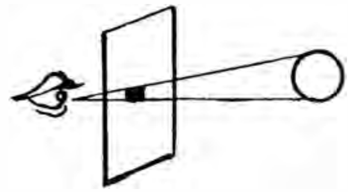


Figure 1
LEONARDO'S SKETCH OF THE VERTICAL GLASS PANE
"Perspective is nothing else," Leonardo wrote, "than seeing a place behind a pane of glass, quite transparent, on the surface of which the objects behind that glass are to be drawn. These can be traced in pyramids [what we would call cones] to the point in the eye, and these pyramids are intersected on the glass pane."

Source: Atlanticus folio 1v

The study of optics confronts one with a multitude of paradoxes. This makes it a particularly useful subject for scientific pedagogy, because, as Lyndon LaRouche, Jr., has elaborated in many published locations,[1] human creative discovery takes place when the mind grapples successfully with a paradox: a clash between one's previous axiomatic assumptions, and an undeniable reality that cannot be explained according to those axioms.

Our classes with these young children were a small step in the direction of such a pedagogy. Our purpose was to engage the children's minds in understanding that such paradoxes exist, and imagining how they might be overcome. We did not follow Leonardo literally, but relied upon him as our muse,

Figure 2
THE *CAMERA OBSCURA*

To build a camera obscura, *you will need:*

- *Large cardboard box, big enough for child to sit inside. A box that a large household appliance comes in works well.*
- *Small cardboard box, about 6 inches deep*
- *Masking tape or duct tape*
- *Piece of white tracing paper*
- *Aluminum foil*

(1) Assemble the small box: Cut off the bottom and replace it with a piece of tracing paper, fastened with masking tape. The top of the box should be open.

(2) Cut out a small square of aluminum foil, three or four inches on a side. Poke a hole in the center with a pin. Enlarge the hole slightly by wiggling the pin around just a bit.

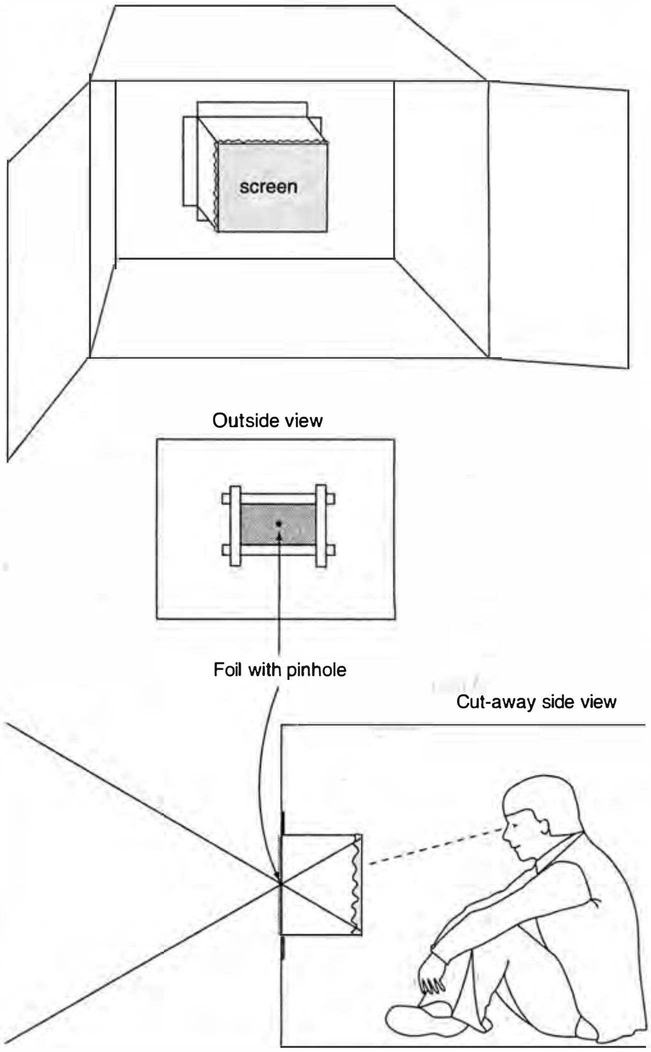
(3) Cut a hole about one inch square in the large cardboard box, at the level of a child's face when sitting inside the box. Tape the square of aluminum foil over this hole, so that the pinhole is in the center.

(4) Tape the small cardboard box securely inside the large cardboard box, over the pinhole. Use duct tape to cover any cracks that would let light in.

(5) Using duct tape, cover up any cracks in the large cardboard box that would let light in. You will be able to find these easily if you climb inside the box. You want light to come into the camera obscura only through the pinhole.

(6) Take the camera obscura *outside on a sunny day. With the Sun behind you, point the pinhole in the direction of a scene that is well illuminated. Brightly colored objects (or people), with sharp contrasts of dark and light, work best.*

(7) Climb inside the box and give your eyes a few minutes to adjust to the dark. Looking at the screen of white tracing paper, you will see the image outside projected onto the screen, upside down and backward.



(8) To get the clearest, brightest image possible, experiment with enlarging the pinhole slightly. What happens if the pinhole gets too big? If the image is very dark, make sure you do not have light leaking into your box through cracks.

whose genius and enthusiasm provided unity to a class series that touched on many diverse subjects. We did *not* attempt to teach the complex science of optics, either as Leonardo understood it, or as it is understood (or misunderstood) today. That would be a much more ambitious undertaking, appropriate for an older age group (and requiring a teacher better qualified than this author, so far, is).

The Science of Perspective

Let us start where we left off, in the previous article: with geometry. After the children had built Platonic solids out of drinking straws and pipe cleaners, they viewed a slide show, which included many of Leonardo's beautiful drawings of the Platonic, Archimedean, and other solids, prepared in collaboration with master geometer Luca Pacioli. The children took turns holding their own solids in the beam of light from the slide projector, thus projecting the outline of the solid onto the screen, where Leonardo's drawing of the same shape was also projected. They enjoyed "giving Leonardo a test," to see how well he had drawn the shape in perspective.

The importance of the science of perspective cannot be overemphasized. It is not just some technique for "making things look real"; it is one of the most important scientific discoveries in world history. As Karel Vereycken points out, in an excellent article in *Fidelio* magazine,[2] it was the development of perspective as a science that *gave rebirth to civilization* in the Renaissance. Among other achievements, it took mankind from the age of craftsmanship, to the age of industry: It was no longer necessary to build wooden models of artillery pieces or machine tools, for example; they could be built straight from drawings.

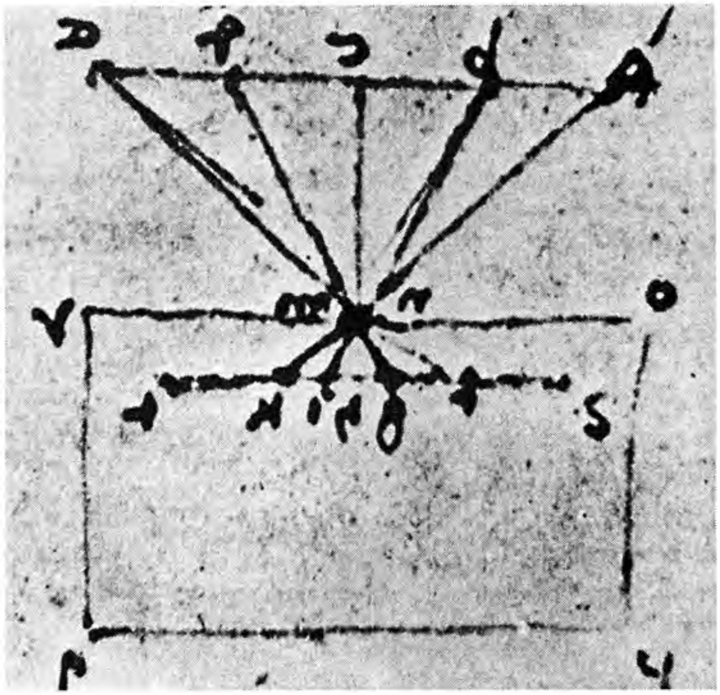


Figure 3
LEONARDO'S DIAGRAM OF THE PRINCIPLE OF THE *CAMERA OBSCURA*
The object is abcd (written backwards, on the top line). From it, rays go through the small hole mn, cross, and then diverge onto a sheet of paper, st. The image is reversed from right to left, and is upside down.

Source: Manuscript D, folio 8r

Leonardo's drawings of machines are a case in point.

The Renaissance discovery of perspective has a further important dimension. It cannot be approached by the rules of Euclidean geometry, by normal "classroom mathematics," because it is a *physical geometry,* a geometry of processes in nature. Our perception of an image involves the physics of light, the morphology of the eye, the physiology of the brain, and, uniquely to human beings, the cognitive function of the mind. It should thus come as no surprise to find that the Renaissance artists' exploration of perspective is inseparable from their celebration of the glory of God and His creation, and their depiction of man in the image of God.

Following our Leonardian slide show, came a four-week series of drawing classes. In one class, instructor Susan Ulanowsky took the children outside, and had them "measure," with index finger and thumb held before their eyes, the apparent height of a person standing 10 feet away, then 20 feet away, then 30 feet away. What happens? Is the person really getting smaller? Ah, our eyes are playing tricks on us! Yet our brain tells us that the person has not really shrunk, but is *farther away.* How interesting! How do we draw that?

Leonardo approached the problem, in a first pedagogical approximation, for his students, by use of the "vertical glass pane" (see photo and Figure 1).

The first paradox that surprises one, in using this device, is how *small* the image is on the glass, even when the subject you are drawing is not far away, and looks "about the normal size." Try it yourself, and see if you can figure out why that is so.

The *Camera Obscura*

Another delightful paradox, is that presented by the *camera obscura* ("dark room"). This device (Figure 2) was used by artists before Leonardo, in their study of perspective and the behavior of light. Here is how Leonardo describes it:

"An experiment, showing how objects transmit their images or pictures. . . . The images of illuminated objects penetrate into a very dark room by some small round hole. Then you will receive these images on a white paper placed within this dark room rather near to the hole; and you will see all the objects on the paper in their proper form and colors, but much smaller; and they will be upside down by reason of that very intersection. These images, being transmitted from a place illuminated by the Sun, will seem as if actually painted on this paper, which must be extremely thin and looked at from behind. And let the little perforation be made in a very thin plate of iron."

In our class, we made camera obscuras out of cardboard boxes large enough for a child to sit in. The students enjoyed "turning one another upside down" (after confirming that it did not hurt), and drawing the inverted image on a piece of tissue paper placed inside the box.

How does it work? Figure 3 depicts Leonardo's understanding of what is going on. There is some resemblance to what goes on in the eye, but only as a first approximation. The eye of a living creature is far more complex than a *camera obscura,* as Leonardo knew very well.

Reflection and Refraction

The reflection of light by mirrors and its refraction by lenses is a vast topic, which could be explored in depth, in an expanded "Leonardian" curriculum for children. Our introduction to the subject was brief.[3]

We began by asking who could explain what a lens is. Nobody was quite sure. Someone suggested that lenses make things look bigger. Well, let's see: We used petri dishes and watch glasses (marketed as an overpriced kit under the label "Edible Optics") to make concave and convex lenses out of Jello, then shone rays of light through the lenses to see what would happen. While the enterprise was amusing, the lenses produced were of about the quality you would expect from gelatin, and at least one child became so preoccupied with her desire to eat the Jello, that her concentration on the lesson faded. Perhaps this feature of the curriculum should be scrapped—especially if the class is close to lunch-time!

Next, we explored another kind of lens: a glass of water. Try this experiment, suggested by Leonardo:

"If you place a ball of glass full of water in front of the eye, all the images of

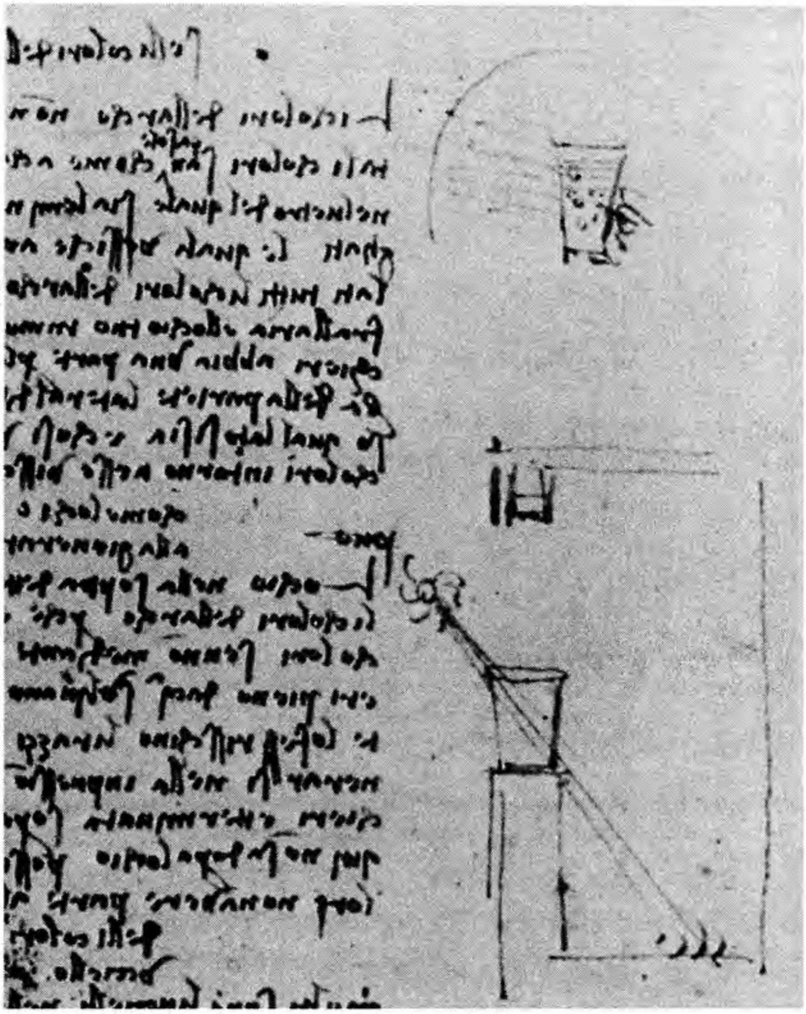


Figure 4
LEONARDO'S EXPERIMENT TO SPLIT UP LIGHT INTO THE COLORS OF THE RAINBOW

Above, the eye looks at a ray of light directly through a glass of water; below, a beam of sunlight shines through the glass and the colors of the spectrum are projected onto a screen below. Leonardo concluded from this experiment, that it is not the eye that produces the colors.

Source: Windsor, folio 19150r

objects that pass through it will appear upside down; and if you place 2 [glass balls full of water] one behind the other, the images of the first will appear to the eye to be re-erected into their natural direction."

Instead of glass balls, use a brandy glass or other glass with a fairly round bowl. Look through these at a lamp. The second, re-erected image is tricky to see at first: You have to find the *quite small* image of the glass that is farther away from you, in the bowl of the glass that is closest to you. The image of the *glass* will be inverted, but the tiny image of the more distant lamp "inside" that glass will be rightside-up.

Rainbows

Finally, we had some fun with rainbows, with the help of instructor Elijah Boyd. "How does a rainbow come about?" I asked one child. Her answer: "Jesus makes a big soup, and stirs it up, and takes green from the grass, blue from the sky, all the colors, and that's how you get a rainbow." After I recovered from that one, I told the children what Leonardo thought about it:

He asked himself, are the colors of the rainbow created by the eye of the viewer, as many people believed in his day? He devised an experiment that decomposed a beam of sunlight into its fundamental colors, and displayed the spectrum on a screen. This convinced him that it was not the eye which produced the colors (Figure 4):

"How the eye has no share in producing the colors of the rainbow. Place a glass full of water on a window sill so that the Sun's rays will strike it from the other side; then you will see the aforesaid colors formed in the impression made by the Sun's rays that have penetrated through that glass and ended on the floor in a dark place at the foot of the window. And because here the eye is not exerted, we can evidently and with certainty say that such colors do not have anything to do with the function of the eye."

Isaac Newton is generally credited with having done the first experiment showing that refraction through a prism decomposes light into the colors of the spectrum. In fact, as this experiment shows, the credit belongs to Leonardo.

Another question Leonardo posed was: Does everybody see the same rainbow in the sky, or does each see a different rainbow, depending on where they are standing?

Neither I nor my students are fully prepared to answer that one. For one thing, you seldom see rainbows in this part of the country. (In my youth, I saw lots of them. Is it a question of geography, or have rainbows become a victim of the "post-industrial society"?) But then, early this summer, I heard a shriek from the backyard, where my son was watering the lawn with a hose: "Mommy, come quick, I made a rainbow!" I saw it, and he saw it. And, we're pretty sure we caught a glimpse of Leonardo there, too, looking over our shoulders.

In the next part of this series: conic sections and conical growth patterns in living organisms.

Notes

1. See, for example, Lyndon H. LaRouche, Jr., "Why We Must Colonize Mars," *21st Century*, Winter 1996-1997, pp. 23-25.
2. "The Invention of Perspective," *Fidelio*, Winter 1996.
3. Useful resource books on optics for children include Bernie Zubrowski, *Mirrors: Finding Out About the Properties of Light* (New York: Morrow Junior Books, 1992), and Robert Gardner, *Investigate and Discover Light* (Englewood Cliffs, N.J.: Julian Messner, 1991).

Little Science or Reason, Just Population Reduction

by Dr. Malcolm Ross

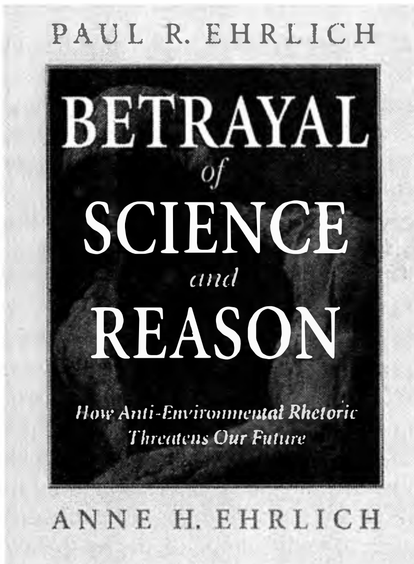
Betrayal of Science and Reason
Paul R. Ehrlich and Anne H. Ehrlich
Washington D.C., Corelo, Calif.: Island Press/Shearwater Books, 1996
Hardcover, 335 pages, $24.95

How does one review a book whose authors believe that there is no reason that the population of the United States should be greater than 135 million; that 130 million of our citizens are excess baggage; that our military defense costs are only to enrich certain "patrons"; and that one of the most environmentally damaging activities of human beings begins in the bedroom?

Paul Ehrlich is a professor of biology at Stanford University and is most noted in non-academic circles for his 1968 book, *The Population Bomb,* in which he predicted—incorrectly—the coming doom of mankind. In academic circles, Paul Ehrlich is best noted for his research on insect populations.

Since the publication of the *The Population Bomb,* Ehrlich has written several more books, some with his wife, Anne Ehrlich, as a co-author, which continue to elaborate on the conjecture that the survival of planet Earth depends on curtailing world population growth and industrial advance. The present book, *Betrayal of Science and Reason,* is the latest of this series on man and the environment.

The main purpose of this book is to discredit those scientists and journalists who find fault with the ideas and policies promoted by advocates for protecting the planet. In the world according to the Ehrlichs, the environmentalists are the good guys who wear white hats and ride into the fray on white horses to rescue the Earth from environmental degradation; they are the "greenlash" heroes whose scientific conclusions are always correct and who do not accept pay from



the capitalist polluters and other anti-environmentalist organizations.

The anti-environmentalists are the bad guys who wear black hats and who want to destroy the Earth; they are the "brownlash" anti-heroes who are often in the pay of private commercial interests and thus may distort their scientific conclusions to satisfy their patrons. The Ehrlichs believe the "brownlashers" (also referred to as contrarians or skeptics), through their activism, prevent equitable solutions for environmental problems and thus must be exposed as misinformed, deceivers, frauds, or ideologues—as the case may be.

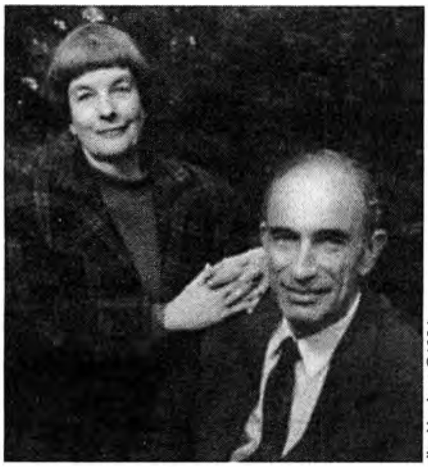
If one is looking for "science and reason," there is little to find in this book. The Ehrlichs do not cite the original peer-reviewed scientific literature to refute the brownlashers' criticisms of the greenlash conjectures. For example, the scientific publications of Patrick Michaels, professor of climatology at the University of Virginia (he is also the Virginia State climatologist) are discredited, because he accepts "six-figure consulting fees from coal and other energy interests."

Dr. Michaels does receive funds to support his research laboratory from various organizations, public and private, but he does not bend his science to suit a client. If he did this, other investigators could easily expose it, by pointing out errors of fact in peer-reviewed scientific journals. Nowhere in this book do the Ehrlichs refute Michaels's work by reference to any scientific journal. This book is written for the non-scientist, so the Ehrlichs feel no need to follow the protocol demanded of the research scientist that requires citation to the scientific literature to support any disagreement with previously published studies.

Complete Ignorance

The Ehrlichs demonstrate a complete ignorance of the literature pertaining to acid rain research. Throughout the 1980s, the U.S. government financed a massive $500 million study of the effects of acid rain. At this same time the environmental advocates were telling the public with thousands of news stories how acid rain was devastating the forests of the eastern United States and Canada and that the lakes were dying and were fishless. But by 1989, much of the acid rain research had been completed and the results published in science journals and in the exhaustive National Acid Precipitation Assessment Program (NAPAP) report.

The NAPAP report is dismissed by the Ehrlichs as "a mixed bag"—one wonders if they even read it. This commentator has. The NAPAP studies showed that acid rain had little effect on the northeastern forests; most are in very good condition, and where there was forest damage, it was mainly due to pests, very cold winters, and/or drought. There were only a few lakes in the northeast United States that became acid because of man's activities. Most of the acid lakes



Jim Harrison ©1994

Authors Anne H. and Paul R. Ehrlich

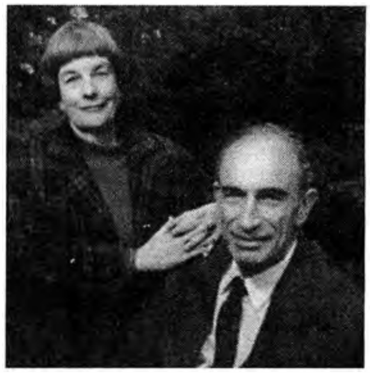
are found in Florida, where there is little acid rain. The NAPAP researchers also reported that as the forests returned, after having been clear-cut in the 18th and 19th centuries, forest soils became acid as a result of decaying organic vegetation. Lakes in these acid forest soil environments returned to their prehistoric condition of acidity as proven by the presence of acid sensitive fossil biota found in the lake sediment cores.

In our studies at the U.S. Geological Survey, we found that one of the more important effects of acid rain was the erosion of marble and limestone building materials. The greenlashers had little to say about these findings and continued to harp on the impending demise of forests and lakes. Dr. Laurence Kulp, who headed the NAPAP program until 1989, was replaced after publication of the preliminary NAPAP report because of political pressure from the greenlashers, for they did not like the scientific conclusions that exposed their false propaganda.

Lack of Understanding

Equally appalling is the Ehrlichs' lack of understanding of modern molecular cell biology and the newest ideas on the origins of human cancer. Although the Ehrlichs accept one of the leaders in cancer research, Dr. Bruce Ames, as among the "legitimate scientists with appropriate credentials" (what an understatement!), they ignore the monumental studies coming from his laboratory.

The Ehrlichs go to great pains to discredit the studies of Ames and his colleague Lois Gold (pages 160-161). What the Ehrlichs did not tell us in their book are the major points presented in scien-



tific papers of Ames, Gold, and their associates—that simply living on the Earth exposes us to innumerable naturally occurring carcinogens; that naturally occurring chemical carcinogens (as defined by animal experiments) are ubiquitous in the foods we eat; that about 50 percent of the chemicals administered in high-dose animal tests, both natural and synthetic in origin, are found to be carcinogens; that of the approximately 1,000 chemicals found in roasted coffee, only 22 have thus far been tested in animals, and 19 of these 22 were found to be carcinogenic in animals; that many beverages contain large amounts of animal carcinogens; such as hydrogen peroxide, methylglyoxal, formaldehyde, nitrosamines, and ethyl alcohol; that we ingest at least 10,000 times more of Mother Nature's carcinogens than of man-made carcinogens; and that naturally occurring chemical carcinogens at concentrations of 50,000 parts per billion or greater are found in such common foods as apples, cauliflower, carrots, celery, cabbage, bananas, potatoes, lettuce, broccoli, and mushrooms.

"If one is looking for 'science and reason,' there is little to find in this book."

Despite human ingestion of many naturally occurring carcinogens, they have little effect on cancer induction except in special classes of societies where extremely large amounts of certain foods and beverages are consumed—for example, fats, bracken fern, betel nuts, and alcoholic drinks. The studies of Sir Richard Dole and Dr. Richard Peto show that human cancers are largely due to smoking, diet, and bacterial and viral infections; exposure to man-made

chemicals contributes very little to overall cancer mortality, thus refuting the fear-mongering pronouncements of the anti-chemical greenlashers.

Disgraceful

The Ehrlich treatment of journalists who do not follow the greenlash party line is especially disgraceful. They particularly single out Gregg Easterbrook as the most villainous of the brownlash reporters, partly I believe because of Easterbrook's stature as an environmental writer and the 1995 publication of his influential book *A Moment on the Earth: The Coming Age of Environmental Optimism.* This book is an exhaustive 745-page review of much of environmental science and policy. The main points of Easterbrook's analysis are: that we have made great headway in improving our environment, that we should acknowledge this progress, and that the doomsaying orthodoxy of the greenlashers is greatly inflated.

In contradiction, the Ehrlichs believe that our planet is still in a desperate condition; thus they find it necessary to discredit Easterbrook's assessment. For example, they quote the following statement made by Jack Schultz, an entomologist at the Pennsylvania State University: *A Moment on the Earth* "contains some of the most egregious cases of misunderstood, misstated, misinterpreted, and plainly incorrect 'science' I've ever encountered" (in *Natural History,* Aug. 1995). Perhaps the Ehrlichs did not make such a statement themselves for fear they could be sued for libel (*Betrayal of Science and Reason* was vetted by a lawyer specializing in libel law).

Criticisms of Easterbrook are particularly trivial and picky; for example, he placed an insect in the wrong family and he violated the second law of thermodynamics (that's a good trick for a journal-

ist to accomplish). To further discredit Easterbrook, the Ehrlichs state that he wrote "a for-hire biography of C. Everett Koop," the former Surgeon General of the United States. Imagine writing for profit!

Scientific Optimism

It is difficult for me as a professional scientist to respond to the question presented at the beginning of this commentary, for the Ehrlichs' *Betrayal* is a political and social polemic, masquerading as a scientific treatise. I also consider myself a humanitarian, believing that human progress is accomplished through better and better application of our technical expertise to improving the quality of the world around us, while at the same time sustaining our moral commitment to all humanity.

With our technical accomplishments, the world is becoming a better place to live, both for humans and for the fauna and flora. This is amply demonstrated by comparing the relatively clean environments of the Western industrial nations to the terrible conditions in the poorly developed nations. However, the greenlashers, including the Ehrlichs, do not recognize the great benefits of modern technology. They believe humans are destroying the Earth, thus human populations must be greatly reduced; by what means they do not say. By slow-motion holocaust?

"To know a fly is to love one."
—Paul R. Ehrlich and Anne H. Ehrlich

It is sad to say that in much of the greenlash literature there is expressed a visceral hatred of humanity. The Ehrlichs make a pungent statement that exposes their anti-humanitarianism, "To know a fly is to love one" (page 109). Nowhere in their book did I read "to know a human being is to love one."

Malcolm Ross is a Scientist Emeritus at the U.S. Geological Survey in Reston, Virginia.

Treat Yourself to a Dose of Optimism

Mission to Mir
Produced by IMAX Corp., Lockheed Martin Corp., 1997
Video, 40 minutes, $12.00

The photograph on the cover of this issue of *21st Century* is a still picture, taken from the newest IMAX space film, "Mission to Mir." As beautiful as it is, no photograph could capture the thrill of a launch into space, the majestic view of the Earth from orbit, or the excitement of the crew members who make these daring journeys beyond their home planet. "Mission to Mir" captures these dramatic views in film, shot by the astronauts themselves, of Space Shuttle and Soyuz launches, the linking up of the Shuttle and the Mir in Earth orbit, and the activities of the cosmonauts and astronauts on board both spacecraft.

One striking difference between "Mission to Mir" and all the space movies made before it, is its first-time footage of the Russian space program—a space program that had been cloaked in secrecy by the Soviets for nearly four decades. The film opens with the preparation and launch of a Soyuz rocket, with cosmonauts, military personnel, and space agency engineers readying the launch from the Baikonur Cosmodrome in Kazakhstan.

Since the premier of "Mission to Mir" at the Smithsonian Air & Space Museum in Washington, D.C., on May 21, the situation onboard the Mir space station has changed dramatically. The June 25 collision of an unmanned Progress supply ship with the station, makes the inside look at the space station even more immediate than what the film-makers had in mind initially.

The tours through the Mir by cosmonauts and astronauts, filmed with an IMAX camera for "Mission to Mir," provide a context within which to think about the difficulty the Mir crew will encounter in trying to fully recover from the Progress accident. The modules are crammed with equipment, wires, packages, and supplies that collected there over the 10-year lifetime of the space station because, until the Shuttle started visiting the Mir two years ago, the Russians had little capability to bring cargo back to Earth.

The Shuttle/Mir program, with Shuttle astronauts visiting and living aboard the Russian station, is more than a collaboration in space.

Film footage of the teams training together, and getting to know each other and their families as friends, provides an insight into why the program has gone so well.

Mutual Respect

There is a justifiable pride each nation feels in its space achievements. An historical sketch at the beginning of the movie recaps how the two space programs were separate, and rivals, until 1994. Now, each nation has tied its future space exploration to the other. The tie that binds is the mutual respect, and affection, that has developed between the astronauts and cosmonauts who are the quintessential expression of space exploration. And this relationship is revealed to the public in "Mission to Mir."

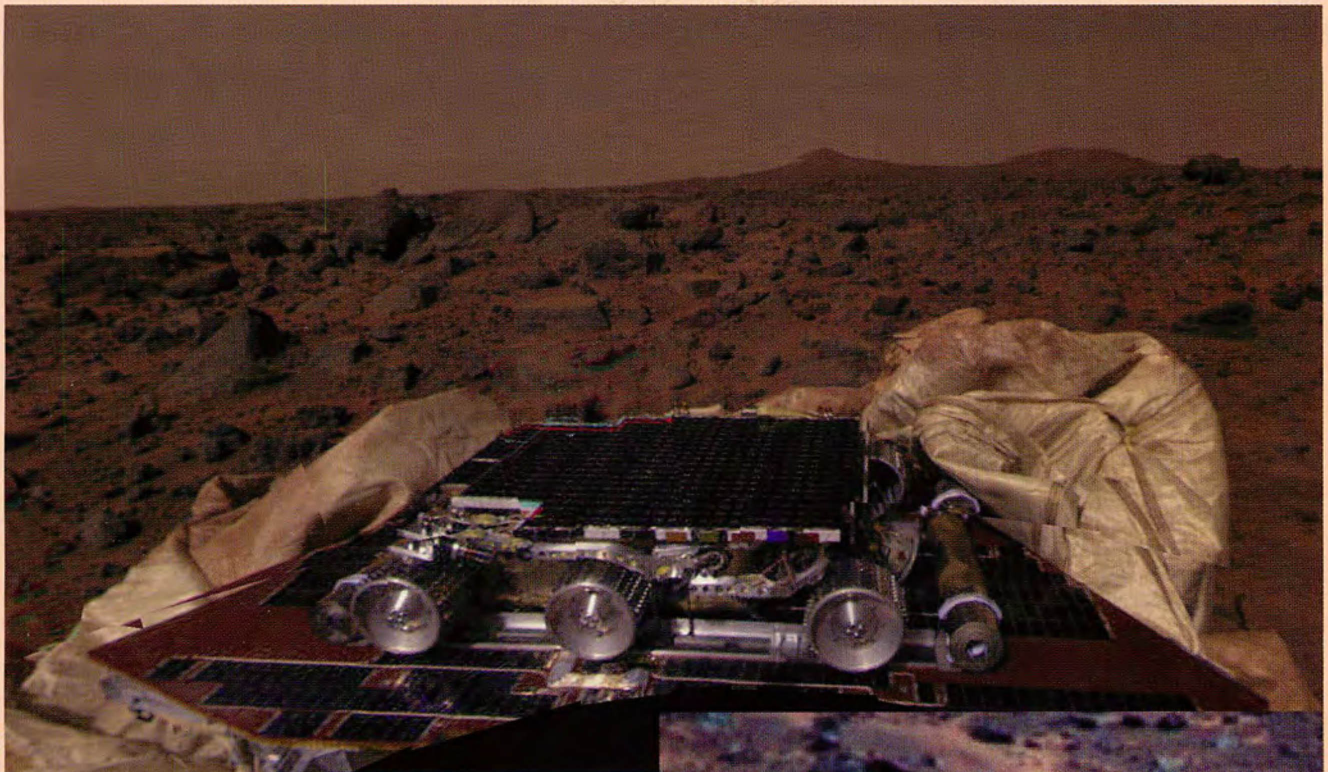
To make this film, seven astronauts, and cosmonaut Vladimir Titov, were trained to use the 85-pound hand-held IMAX camera. A second, larger, camera was in the payload bay of Atlantis. The inflight film footage was taken during three docking missions, and the first rendezvous mission. The IMAX team also made three trips to Russia to film the Soyuz launch, crew training, the cosmonauts with their families and entertaining astronauts, and one of the factories where Russian rockets are manufactured.

The audience watching the film shares the triumph of both crews at the success of the first docking of the Shuttle orbiter Atlantis with the Mir, and the sadness when the hatch between the two giant spacecraft is closed and friends depart, as the Shuttle heads back to Earth.

"Mission to Mir" is now showing in more than a dozen IMAX theaters throughout the United States and in Canada and Australia. Additional theaters will start to show it throughout the fall.

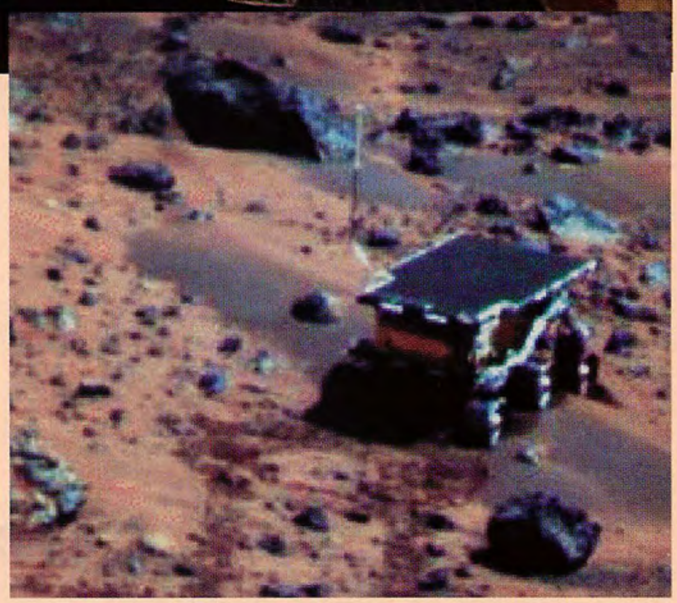
Give yourself a treat. Spend 40 minutes with the astronauts and cosmonauts who open up the world of space exploration for us all.

—*Marsha Freeman*



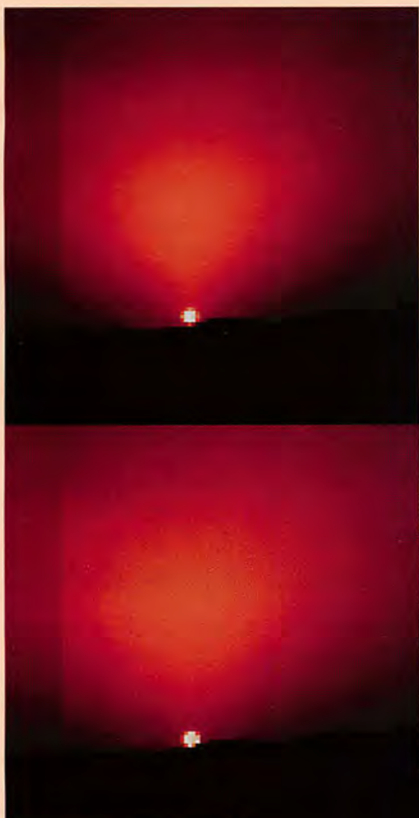
JPL/NASA

The Sojourner rover, nestled on the Pathfinder lander before moving onto the surface of Mars.



JPL/NASA

Sojourner on Sol 30 (Aug. 3), crossing Mermaid Dune, a dark area in comparison with the surrounding bright surface. The rover tracks can be seen, from the foreground to the base of the rover's wheels.



JPL/NASA

JPL/NASA

Sunset on Mars, showing a fan-shaped scattering of light. Above left, false color views of the sunset.

Pathfinder Discovers a New Mars

by Marsha Freeman

For the first 20 years of the space age, the photographs that we had of Mars, from both the Earth and space, showed a planet with ice at the poles, evidence of dust storms, and little further detail. The red planet appeared disappointingly boring.

In 1976, the Viking orbiters arrived at Mars and revealed a fabulous planet of massive volcanoes, a canyon stretching 3,000 miles, and other evidence of geological and hydrological activity. But the two Viking landers were set down at sites chosen for their relative featurelessness, not their geological importance, to enable the spacecraft to land safely, Apollo-style, on their delicate, spindly legs.

JPL/NASA

Viking provided us with the first ground-level photographs of the rocky, sandy surface of Mars, and the first *in situ* measurements of the characteristics of the atmosphere and the soil. However, scientists have been itching to go back to Mars, and touch down in a region of the planet that would reveal more of its geological and climatological history.

On July 4, the Pathfinder lander, with its companion rover, Sojourner, did just that, landing precisely on target, on the ancient flood plain named Ares Valles. Although the landing is only about 500 miles from the flatlands of Viking 1, the new region chosen by scientists has hills and craters, and a variety of rocks that have been washed downstream into the flood plain by the catastrophic release of an amount of water comparable to that in the Great Lakes.

Continued inside on page 22

JPL/NASA

Wedge and Flat Top, two of the rocks Sojourner is studying.

Above, Mars, with the massive Vallis Marinaris canyon straddling the equator. The arrow points to the approximate site of Pathfinder, on the ancient flood plain in the Ares Valles area, at 19.33°N latitude, 33.55°W longitude.

JPL/NASA

Part of a monster panorama of the Pathfinder site, created as a mosaic of photographs taken with the lander camera. The lander airbags are visible in the foreground. The Sojourner rover is at the top right, near the rock Yogi. On the horizon (center) are the Twin Peaks, which appear to be layered, indicating the repeated action of water.