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Why We Must Go to Space

by Lyndon H. LaRouche, Jr.

Scientific Advisory Board

EDITOR'S NOTE: *We have always maintained that the distinction between the political "mainstream" and the mainline of a major sewer system, is so fine as to exceed the observational accuracy of present-day instrumentation. Now, after years of banishment by the "mainstream," the question of a manned mission to Mars is back on the political agenda.*

Clearly, we cannot leave leadership on so important a question to an Administration led by a man arguably qualified as the dumbest ever to have occupied the office of the Presidency. Nor can it be left in the hands of a scientific "mainstream" whose thinking is characterized by the recent editorial in Science *magazine, which argues that our robotic capabilities have reached such a degree of perfection that manned missions to space are no longer necessary, nor "worth the risk."*

Desiring to give our readers something better in the way of informed discussion of this matter, we chose these selections from a dialogue between the well-known physical economist and current candidate for the Democratic Presidential nomination, Lyndon H. LaRouche, Jr., and members of his youth movement. The discussion took place in Mainz, Germany, January 2004. In attendance were 75 or so young people in the 18- to 25-year age bracket, principally from France, Germany, Sweden, Denmark, and the United States.

The dialogue follows:

Question: A little strange question—

LaRouche: Yes, yes. That's all right, it's a strange world.

Question: I follow the ideas about space travel. . . . Is there anything that goes beyond what you've elaborated so far, about the Mars mission and so forth, concerning space travel beyond the Solar System?

LaRouche: Yes. Yes, there is. But the problem is, right now, first of all, we've got a fundamental problem: The whole space program, by Europe, the United States, and so forth, is essentially incompetent. The Beagle thing merely points up that problem.

You see, you're going into the unknown, and it's like the guy who tries to set up a farm in the middle of the Sahara, without water. That, in making anything work, you have to create the infrastructure, that will support your effort.

Now, what does it take to explore space? First of all, you're going into the unknown. There are a great number of unknowns. The farther you go, the greater the distance you have to operate over, the larger part of the Solar System you're operating in. Because, you know, when you go from Earth to Mars, you're not just going from Earth to Mars. It's not like taking the train, from some place to some place. You're actually going through a very large part of the Solar System, of the inner part of the Solar System. There are a lot of things going on there. This is not simply empty space. Electromagnetically it's very active.

So, now, you're going to an unknown destination—that is, you don't know what you're going to find when you get there. That's why you're going there! You're going there, because you don't know what's there. You know some things that are there, but you're really going there, to find out things you don't know. So, you're going into the *unknown*. Now, when you go into the unknown, the way they're doing it now, it's like sending a cavalry into the desert without any logistics. They're saying, "Well how are they going to get there?"

What you would have to do, what I did, when I designed this program in 1986 for a Mars colonization, that is, put a scientific research station on Mars, I took 40 years to do it.[1] Why? Because I went through, step by step, about the logistical basis you had to build up to make step 1, step 2, step 3, step 4. And, a lot of the stuff I worked with, has been worked with by people in the space program before, who had gone through this, in the Moon stage, so forth; all these kinds of problems. So, what you do, is you build a fail-safe logistical system, a structure. You don't try to sneak some small object at the lowest price into some destiny, and hope it works! Because it probably won't.

But if you have built a system—if one object doesn't work, you're going to sit back, "What do we do next?" "Well, 10 years from now, we'll do the next one. That failed." What you're going to do, is build a logistical system first, which can deliver and support these kinds of objects. So if one fails, you're immediately in place to make the next one. If you get a bunch of [people] who go out in space, and they're distressed, how are you going to rescue them? You better have a system out there, which can anticipate that problem and deal with it.

The basic problem is, we are not thinking—the same way we don't think about infrastructure on Earth any more, we don't think about the need for infrastructure, in going into space. Space exploration requires building a *human infrastructure for space exploration.* Which means, you have to have systems and supporting systems planted all over the place. And you operate *then,* within those supporting systems.

They're not doing it. They're also doing the "el cheapo" thing. Who's my crooked brother-in-law, who needs the business? That kind of thing. And that is not a good way to run a show.

Question: On the question of Mars, I want to know when you talk about a step-by-step operation to get human life there, I suppose it's in the same way than the idea, of, you know, you point to a physical principle, still undiscovered, like you made with [inaud]; and from this future, you come back to present time, step by step. I have a block on this—how you can take it this way? This is as Schiller described in history, understanding, so I have a hard time with that.

LaRouche: Yes. The point is, we want to know, Kepler wanted to know what the Solar System was like. We still don't know the Solar System very well. There are certain frequencies we don't know. We don't know how the universe is really organized. So, what we have to keep doing, is we keep going out, to find anomalies at a greater distance from what we already know; to find things that will show us, indications of what it is we are not seeing, not understanding.

So, the idea of a Mars exploration, for example. My intention was, was the Solar System as a whole. We have to know: How does the Solar System actually work? Well, to do that, the Sun is very noisy. You may not have noticed it, but it's terribly noisy. It's a very noisy neighbor to have. And it's our neighbor. So, the farther you get away from the Sun, the better chance you have of getting some insight into what the universe looks like, in terms of electromagnetics. That is, you want to observe, on a large scale, you want to build big apparatuses, which can, with some degree of refinement, look at the stellar system, look beyond the Solar System, and begin to see things we can't see now, that we don't know. Or, we want to build things at a distance from the Earth, where we have less intense interference from the Sun.

The Crab Nebula Paradox

We want to find out how these various star systems work. We can make observations, like this Crab Nebula business. Years ago, I heard about this Crab Nebula, which the Chinese had been the first to observe as a supernova. And then, I got more and more curious about this thing—what an anomaly it is, in terms of the principles involved, we don't know, which are obviously there. What is it? Then, [nuclear scientist Erich] Bagge, reported to me this business about cosmic ray radiation detection: Most of the cosmic ray radiation hitting the Earth, is coming from the Crab Nebula. And this was determined by these arrays, which they had up in northern Germany. And then, they have a smaller set-up in England, so they correlated the two, and the Crab Nebula is the source of this intense radiation. And, it's a completely anomalous phenomenon, from anything we know.

So, we want to know what this is. Because, if this happens in the universe,

Continued on page 64

Letters

On the Origins of The Polynesians

To the Editor:

My previous article on the Pitcairn Island Petroglyph, published in the Winter 2001-2002 edition of *21st Century* (Pitcairn Island Petroglyph Deciphered), illustrated the possibility of an expedition across the Pacific Ocean in 233 B.C., utilizing lunar eclipses as a means of navigation. Although this article is of some scientific interest, it has far greater historical significance as the possible origin of the Polynesian society in the Pacific region.

Considerable time and effort has been expended by leading anthropologists over the last 80-odd years in an attempt to solve this enigma.[1] The early Maoris in New Zealand always referred to their homeland as "Hawaiki" which caused great interest at the time, but means literally "over there" (Fijian—*mai keya,* meaning from that place there).

However, after considering the opinions of various anthropologists, it would seem that the Marquesa Islands were the most likely source of the origin of the Polynesians. After observing the eclipses at Pitcairn and Chile, the 3rd Century B.C. Egyptian expedition, having replenished its food supplies, was swept northward by the Humboldt current joining the South Equatorial Current, eventually making landfall in the Marquesas.

One most important item in their food supplies was *Ipomoea batatas,* commonly known as the sweet potato (Maori *kumara,* Fijian *Kumala*). This item is now readily available throughout the Pacific and forms the staple diet of all islands.

Subsequent expeditions have discovered ancient stone artifacts and petroglyphs, which bear a marked similarity to New Zealand Maori carvings.

Ross Perfect
Queensland, Australia

Notes

1. For example, see *Hawaiki* by S. Percy Smith, 1921; *From Maui to Cook* by D. Lewis, 1977; *The Polynesians: Prehistory of an Island People* by Peter Bellwood, 1987; and *Fatu-Hiva* by Thor Heyerdahl, 1974.

DOE

Dr. Rusi Taleyarkhan, principal investigator in this sonofusion effort, shown here in his Oak Ridge National Laboratory. He is now at Purdue University.

NEW EVIDENCE REPORTED FOR 'BUBBLE' COLD FUSION DEVICE

A team of researchers released new evidence in March replicating their previous experimental results with a tabletop "sonofusion" device, which had produced nuclear emissions. The experiment uses an ultrasonic wave to form and implode cavitation bubbles, which causes high compression and high temperatures (100 million degrees Kelvin), and produces nuclear emissions. The scientists, from Purdue University, Rensselaer Polytechnic Institute, Oak Ridge National Laboratory, and the Russian Academy of Sciences, report their findings in a March article in *Physical Review E.*

Dr. Rusi P. Taleyarkhan, a professor of nuclear engineering at Purdue University, who led the work, stated: "What we are doing, in effect, is producing nuclear emissions in a simple desktop apparatus. That really is the magnitude of the discovery—the ability to use simple mechanical force for the first time in history to initiate conditions comparable to the interior of stars." Taleyarkhan said that his group had received additional funding from the U.S. Defense Advanced Research Projects Agency, and was able to use more precise instruments to collect more accurate data. The first experiments were reported in *Science* two years ago.

The sonofusion device is a glass canister, about the height of two stacked coffee mugs, which contains a deuterated acetone liquid. Pulses of neutrons every 5 milliseconds cause tiny cavities to form in the liquid inside the canister. Simultaneously, the liquid is bombarded with a specific frequency of ultrasound, which causes the cavities to form into bubbles, about 60 billionths of a meter in size. The bubbles then expand to 100,000 times that size, and can be seen with the unaided eye. Within nanoseconds, these larger bubbles contract to their original size, producing flashes of light, known as sonoluminescence. In this process, the deuterium atoms in the acetone fuse together, releasing gamma rays and tritium, which have been measured by the researchers. The surges in neutron emission are precisely timed with the light flashes. The next step is scale-up of the device, to produce breakeven.

MERCURY IN OCEAN FISH MAY BE FROM NATURAL SOURCES, NOT POLLUTION

A study that appeared in the Dec. 15, 2003 issue of *Environmental Science & Technology,* a journal published by the American Chemical Society, reports that mercury levels in yellowfin tuna caught off the coast of Hawaii have not changed in 27 years, despite a large increase in atmospheric mercury. This suggests that the high levels of mercury found in tuna and other fish may not be coming from pollution. According to one author of the study, François Morel, professor of geochemistry at Princeton University: "We have about tripled the mercury in the atmosphere, and therefore it should be tripled in the ocean, right? But maybe the mercury that occurs in fish is a natural thing, and it may have been there all along." Dr. Morel suggests that the natural source could be hydrothermal vents and deep ocean sediments.

NASA

The black X-43A rides on the front of a modified Pegasus booster rocket, hung from the special pylon under the wing of NASA's B-52 mother ship, shown here during a captive carry flight in January.

NASA TO TEST AIR-BREATHING SCRAM JET X-43A VEHICLE

An unpiloted 12-foot long vehicle, part aircraft and part spacecraft, will be dropped from the wing of a B-52 aircraft March 27, boosted to about 100,000 feet by a booster rocket, and released over the Pacific Ocean to fly under its own power at seven times the speed of sound. The brief flight is part of the Hyper-X program, which aims to demonstrate hypersonic air-breathing technologies for use in the atmosphere and in space. Although wind-tunnel tests have been successful, this will be the first time a non-rocket air-breathing scramjet engine has powered a vehicle in flight at hypersonic speeds. The X-43A will glide through the atmosphere and conduct a series of aerodynamic maneuvers, before splashing down.

For more on the Hyper-X, see "Hypersonic Flight Ready for Takeoff" in the Fall 2001 *21st Century.* NASA has posted information on the project on the internet at www.nasa.gov/missions/research/x43-main.html.

BRING BACK DDT TO CONTROL MALARIA, AFRICANS URGE

As malaria continues to kill increasing numbers of human victims, some African health officials are campaigning to bring back DDT spraying as the most effective weapon in stopping malaria-carrying mosquitoes. DDT sprayed on the inside walls of houses once a year has been proven to control malaria. An article in BBC News, March 5, reported that these health officials were battling Western groups who, because of Malthusian environmentalist lies, would not give funds for anti-malaria programs that used DDT. These donors include U.S. AID, the British Department for International Development, and the United Nations Roll Back Malaria program.

For documentation on the efficacy of DDT—and the politics and lies that banned it—see articles on the *21st Century* website www.21stcenturysciencetech.com. A special collection of four articles on DDT from past issues is available for $15.

'ALIENS CAUSE GLOBAL WARMING,' SPOOFS SCI-FI WRITER CRICHTON

Science fiction writer Michael Crichton elegantly exposes the cult of science and the needless deaths caused by environmentalist lies (such as the ban on DDT), in two recent speeches.

In "Aliens Cause Global Warming," Crichton argues that the search for extraterrestrials beginning in the 1960s was a religion, an act of faith, which served as a foot in the door for "pure speculation in quasi-scientific trappings," and paved the way for subsequent hoaxes disguised as science. He attacks the idea of "consensus" as not being science. He also exposes as ridiculous computer models taken as generating data, as if that were reality. Finally, he gets to global warming, which as his title suggests, might as well have been caused by aliens, because of the unreality of its claims.

Crichton's speeches can be found on his website: www.crichton-official.com/speeches. See the Caltech Michelin Lecture, Jan. 17, 2003, and Remarks to the Commonwealth Club, San Francisco, Sept. 15, 2003.


Malaria: The Killer That Could Have Been Conquered

The Lies of Rachel Carson

The U.S. ban of DDT in 1972 is responsible for the death of hundreds of millions of people. Read the documentation in these articles by entomologist J. Gordon Edwards.

IN MEMORIAM: DR. WILLIAM PICKERING, FIRST DIRECTOR OF NASA'S JPL

William Pickering, the man who opened the age of planetary exploration, died March 15, at the age of 93. Dr. Pickering became the first director of NASA's Jet Propulsion Laboratory (JPL) in California, at a time when no rocket had yet taken scientific instruments above Earth's atmosphere. During his tenure at JPL, from 1954 to 1976, unmanned spacecraft were crafted to explore the Earth and every planet in the Solar System (except Pluto). For more than 40 years, the world has been reaping the benefits of his vision and leadership.

Dr. Pickering assembled a team at JPL to design the first U.S. satellite, Explorer I, to carry a Geiger counter provided by Dr. James Van Allen of the University of Iowa. The result was the discovery of the rings of radiation surrounding our planet, known as the Van Allen radiation belts. JPL's work was also critical in making possible the landing of men on the Moon during the Apollo program. JPL managed and carried out the unmanned precursor missions which were needed to photograph the Moon and characterize its surface, allowing the selection of landing sites for future astronauts. The lab also practiced the soft landing techniques that would be required to put men there safely, and crashed spacecraft into the surface to study the Moon's properties.

Summing up the accomplishments of U.S. planetary exploration since the 1960s, Dr. Pickering stated: "We are now much more at home in our part of the universe. Just as explorations of Earth in the 1500s and 1600s gave us a picture of our home planet, so did explorations of 1960 to 1980 open our eyes to the real Solar System in which we live."

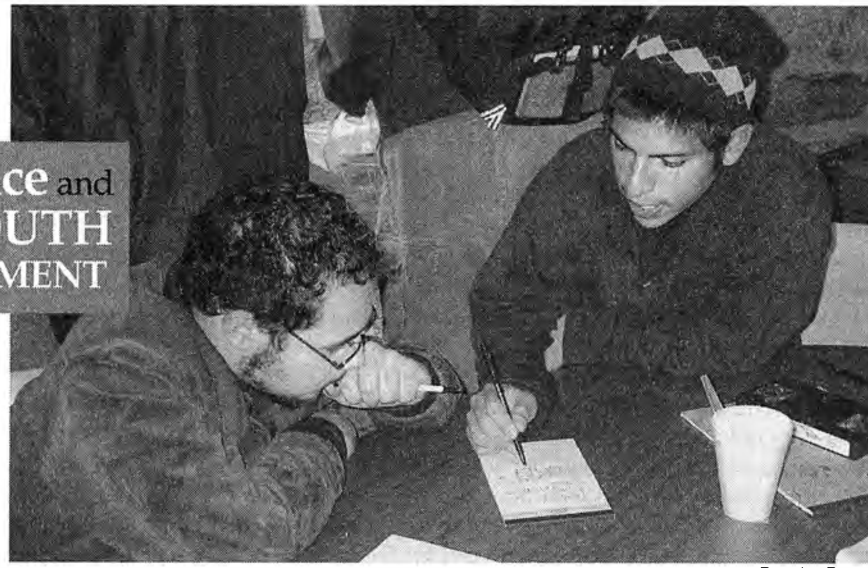

NASA

JPL director Dr. William Pickering (at left), Dr. James van Allen, and Dr. Wernher von Braun proudly display a model of Explorer I during a press conference on the successful launch of this first U.S. spacecraft in Earth orbit, Jan. 31, 1958.

Our Combat Against Empiricism: Escaping Tragedy Through Paradox

by Jason Ross

We in LaRouche's Youth Movement find ourselves in combat with an old enemy that destroys human beings, kills creativity, and brings entire civilizations to their knees. No, it is not the Terminator and the Rise of the Voting Machines; it is empiricism and the complete destruction of *power,* in Plato's sense of the word, in the minds of those whom it infects. To regain the power of mankind to improve our mastery in and over the world, we will return to the Renaissance, but first to Greece, to the dialogues of Plato.



Brendon Barnett

Learning is recollection: LYM members Freddie Coronel (right) and Naji Elabed in a dialogue about doubling the square, at a West Coast cadre school, January 2004.

Plato demonstrates in his "Meno" dialogue, that learning is recollection, and proposes an experiment to illustrate his point. Bringing in one of Meno's slave-boys for the demonstration, Socrates poses a question to him: to double the size of a square that Socrates has drawn in the sand. The first proposal is to double the length of each side of the square, but on trying this, the boy discovers that he has actually made a square four times as large (Figure 1).

Giving it another go, the boy tries making each side one-and-a-half times as large, resulting in a figure that is still more than twice as large (Figure 2). Eventually, returning to the quadrupled square, the idea of cutting each of the four squares in half leads to a "crooked" square in the center, comprised of four triangles, of which the original square consisted of two—a doubled square! (Figure 3). The boy understands the

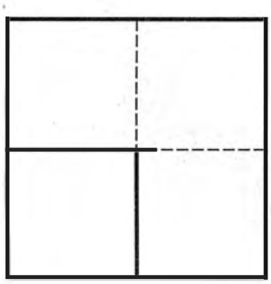


Figure 1
FIRST ATTEMPT TO DOUBLE THE SQUARE
Doubling each side of a square produces a square that is four times the original area.

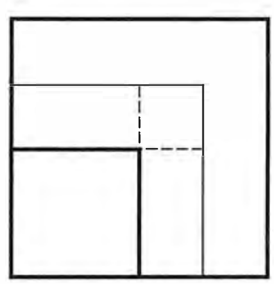


Figure 2
SECOND ATTEMPT TO DOUBLE THE SQUARE
Increasing each side by one-half, produces a square that is more than twice as large.

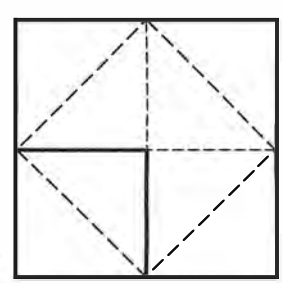


Figure 3
THE DOUBLED SQUARE
By cutting each of the four squares of Figure 6 in half on the diagonal, a new square is produced (dotted lines) which has area of 2.

process and the validity of the discovery, with Socrates merely asking him questions—no declaiming or assertions of fact are made at all.

This discovery is quite remarkable in its demonstration of the inherent cognitive abilities of any human being (try it with strangers—it works!), and in the deeper implications of what we have just discovered. Plato's "Theatetus" dialogue delves into the concept of power in a rich way: The side of the doubled square we have just found is incommensurable with the side of the original square. (See "Burn the Textbooks! Recreate the Original Discoveries," *21st Century,* Fall 2003, p. 8.)

The impossibility of expressing the "square root of 2" as any among the infinite number of fractions between 1 and 2, expresses Plato's notion of power: We have generated something beyond the earlier infinite.

True power is the ability to transform the entire domain of what is possible. Compare this to the simple, infantile notion of power as "more": more horsepower in your engine, more caffeine in your drink, more cup holders, more sex appeal, more choices, more options, more *you!* These consumer notions of power are patently bestial in their implications of human potential. Instead of the immortal power to transform the trajectory of human development to improve our mastery over nature, power is bastardized to mean control over currently existing things.

Light and Power

Let us illuminate our true conception of power by exploring the propagation of light. In Classical Greece, the reflection of light was discovered to occur along a pathway of least distance. This can be demonstrated with an experiment you can perform with two assistants, a string, a mirror, and a flashlight.

You and a friend stand across a mirror resting on a table between you, as you shine your flashlight (held at your eye), onto the mirror right into your friend's eye. Now, both of you hold the string against your eyes, and have the third person put his finger down on the mirror at the spot the light is hitting (see photo, at right).

Now the third person can have some fun! With the string beginning reasonably taut, have him slide his fingers in various directions. Does he find it hard to keep it on the mirror? Is it coming off the glass? What your friend is feeling as the pull, when he moves his finger, is that the path the light took was the path of *least distance;* moving your finger elsewhere requires giving slack to the string to still touch the mirror. Incredible!

How does the light "know" to take the shortest path? "Come on!" our surly physics professor interjects: "The light just bounces off at the same angle it came in at. There's no 'least distance'; it's just an effect of equal angles."

Maybe the professor is right; what *is* the big deal? We will continue our progress and come to discover the importance of this principle.

Now, we examine what happens to light going into water. As you have seen when you put things in water, submerged objects bend and break at the threshold between the air and the water. So what is happening here?

Using the water-tank apparatus in the photo (page 8), we can examine how the path of light changes when we shine light at various angles. We have "bent" paths of light. So what is happening? We will try two different approaches to this problem. One of them is what is taught today as Snell's Law. It states that the sines of the angles (the horizontal lines in Figure 4), are in proportion according to the different speeds of light in the air and the water.

This *describes* the result that we see, but does it explain *why* the light moves in a path with this relationship? We examine the question instead from the standpoint of *intention.* In the case of reflection, we saw that the light took the path of least distance. What is the intention now?

Take the example of a lifeguard rescuing a drowning swimmer. Would the lifeguard run directly towards the swimmer, plunge into the water, and swim directly towards the victim? Only if the lifeguard was a physics graduate from a four-year university. A sensible guard would spend more time running along the beach at a good speed before jumping into the water and swimming the rest of the way. Fermat hypothesized that our humble light beam expresses the same good sense: It is taking the path of *least time!*

"Absurd!!" bellows the empiricist: "How could the light possibly *know* a thing like that? I've read Bertrand Russell—'purpose is a concept which is scientifically useless'—this is quackery! People who think things like this proba-

Sylvia Spaniolo

The light from the flashlight "knows" how to take the path of least distance. The author is at left, shining a flashlight from his eye, to the mirror, and into Jonathan Stuart's eye (at right). They each hold a string up to the eye. Jen Yuen holds down the string with her finger, just at the point the light hits the mirror. If she moves her finger from that spot, it will require slack in the string.

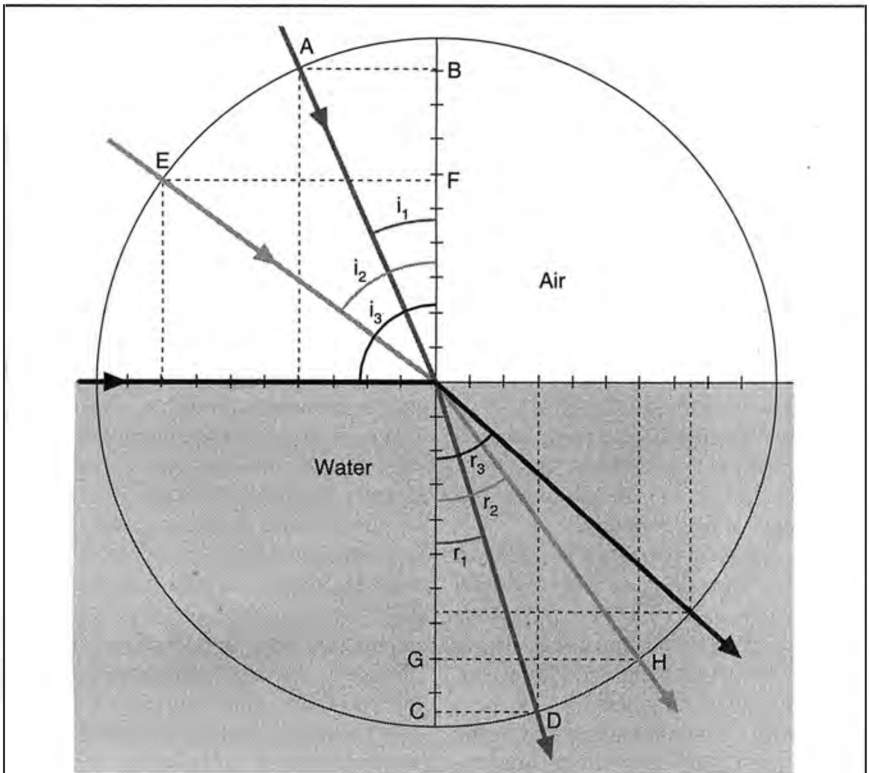


Figure 4
THE LAW OF SINES
The ratio between the sine of the incident angle and the sine of the refracted angle is constant; that is to say, it is independent of the angles of incidence and refraction.

$\sin i_1/\sin r_1 = AB/CD = 4/3$

$\sin i_2/\sin r_2 = EF/GH = 8/6 = 4/3$

$\sin i_3/\sin r_3 = 10/7.5 = 4/3$

bly see value in Kepler's mystical explanation of the planetary orbits. But these 'harmonies' and ideas like 'least time' are the results of the true, deterministic physical laws that govern the universe."

Are we only fantasizing that we have discovered ordering principles in the universe? How can we determine if we have discovered an idea of greater power? Ah, by looking for an expansion of the domain of what we can do, of course!

Bernoulli's Brachistochrone Problem

Shift gears for a moment, as we take up Bernoulli's brachistochrone problem, posed in Leibniz's *Acta Eruditorum* article in 1697: "Mechanical Geometrical Problem on the Curve of Quickest Descent: To determine the curve joining two given points, at different distances from the horizontal and not on the same vertical line, along which a mobile particle acted upon by its own weight and starting its motion from the upper point, descends most rapidly to the lower point."

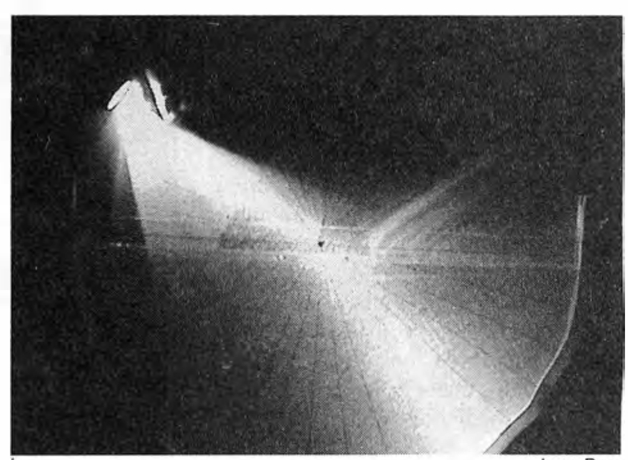
What is the fastest path for an object to fall from point A down to B? Is it a straight line? A half of a circle? A parabola? Or, what if it chances to be a curve generated in a way that is completely unknown to us? This is a problem that cannot be answered from empiricist mathematics or physics. For, among the infinite possible curves, how can we determine one best curve? What if it is physically created in a way that cannot be expressed (as was the catenary before Leibniz); could it then arise as the solution to a question posed in a mathematics in which it is inexpressible? Of course not.

Rather than assume that the solution must exist in an already expressible way, as do Euler and LaGrange—see Gauss's 1799 "Fundamental Theorem of Algebra" (see http://www.wlym.com/text/gauss fundamental.doc), ask instead: What would generate the solution?

Instead of looking at the properties of falling balls, Bernoulli approached this problem with principle. Using the least-time principle governing light, and the hypothesis of an array of changing densities that the light travels through, Bernoulli developed a differential—the principle generating the curve, that shapes its unfolding—and used this to demonstrate that the brachistochrone (least-time path) is, like Huygens's tautochrone (equal-time path), a cycloid. Incredible—we are using light to determine a pathway for a body falling by gravitation (Figure 5)!

Bernoulli uses the following physical idea: Were we to arrange layers of different media atop each other in sheets, arranging them so that the speed of light going through them will increase in the lower sheets, in the same way that a falling object's speed increases with the distance it has fallen, then light travelling through the sheets would (since it is light) take the path of least time, and the arrangement provides that it is the least time for a fall through gravity.

Bernoulli demonstrated that this curve is the cycloid, generated by drawing the position of a point on the circumference



Jason Ross

A water tank apparatus for demonstrating light refraction into water. The light "knows" how to take the path of least time.

of a circle rolling along a line. Bernoulli writes: "Thus I have with one stroke solved two remarkable problems, one optical, the other mechanical, and have accomplished more than I required of others; I have shown that the two problems which are taken from entirely distinct fields of mathematics are nevertheless of the same nature."[1]

Where Snell's law lets us predict light refracting (a process we were already able to create), least time increased our power (*dynamis* in Plato), expanding the domain of human understanding to solve paradoxes.

Bernoulli's solution to the brachistochrone problem made use of the infinitesimal calculus developed by Leibniz, and this too came from light. From Fermat's principle of least-time, Leibniz developed the general principle of universal least action, a conception that completely shook up everything, including physical mathematics.

If all processes in the Universe occur according to a universal principle of least-action, what does this imply about geometry and physics? Well, it means that everything occurs only by principles, along which least *action* can even exist. This means no abstract geometrical considerations can be allowed (for example, shapes *qua* shapes), only actions determined by the governing principles of the universe.

Aha! One hears in the mind, the

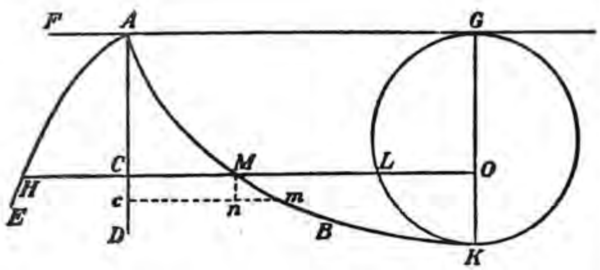


Figure 5
BERNOULLI'S CYCLOID: THE LEAST-TIME PATHWAY OF DESCENT

Bernoulli writes of his demonstration that the least-time pathway of descent is a cycloid:

"In this way we can solve our problem generally, whatever we assume to be the law of acceleration. For it is reduced to finding the curved path of a ray of light in a medium varying in rarity arbitrarily. Let therefore FGD be the medium, bounded by the horizontal FG in which the radiating point A [is situated]. Let the vertical AD be the axis of the given curve AHE, whose associate HC determines the rarities of the medium at the heights AC, or the velocities of the ray, or corpuscle, at the points M.

"Let the curved ray itself which is sought be AMB. Call AC, x; CH, t; CM, y; the differential Cc, dx; differential nm, dy; differential Mm, dz; and let a be an arbitrary constant. Take Mm for the whole sine, mn for the sine of the angle of refraction or of inclination of the curve to the vertical, and then by what we have just said, mn is to HC in constant ratio, that is, $dy : t = dz : a$*. This gives the equation* $ady = t\,dz$*, or* $aady^2 = ttdz^2 + ttdy^2$*; which, when reduced, gives the general differential equation* $dy = tdx : \sqrt{(aa-tt)}$*, for the required curve AMB."*

Source: Johann Bernoulli, "On the Brachistochrone Problem," in David Eugene Smith, *A Sourcebook in Mathematics* (New York: Dover Publications, 1959), p. 652.

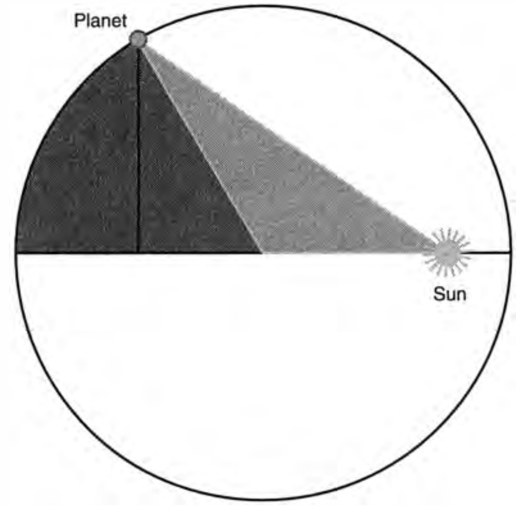


Figure 6
KEPLER'S PARADOX: LOCATING THE EXACT POSITION OF A PLANET AT A GIVEN TIME

Kepler understood that the time of the motion of the planets corresponds to the area created by their motion—equal area is swept out in equal time. Therefore, the position of a planet at a certain time in the future requires finding the position that will sweep out the desired time-area.

For example, to find the position of a planet after a quarter of the planet's year, would require finding the position that would cover a quarter of the entire orbit's area. This area consists of two components: a circular section, and a triangle. The size of the triangle is measured by the distance from the center of the orbit to the Sun, and by the height of the triangle.

The size of the circular section can be measured proportionally to the circular arc of the planet. (The planets move in ellipses, but this paradox can be understood with circles.) But the circular section and the straight-line height are incommensurable: One cannot measure curvedness with straightness, or vice versa. This made it impossible for Kepler to definitively determine a future position of a planet, although he could estimate as closely as desired by breaking the orbit into a number of small pieces and making tables of areas.

beginning of the theme of Riemann's habilitation dissertation: "Space constitutes a particular case of a triply extended magnitude. A necessary sequel of this is that propositions of geometry are not derivable from general concepts of quantity, but that those properties by which space is distinguished from other conceivable triply extended magnitudes can be gathered only from experience."

The necessity for Riemann's polemical dissertation came from the millennia-old separation of geometry, as an abstraction, existing independent of the physical universe. The paradox that prompted Leibniz's development of his calculus arose when abstract, dead geometry was imposed on Kepler's active physical principle of gravitation—giving rise to the so-called Kepler paradox.

When a higher-order idea is projected or expressed in a lower domain in which it is inexpressible, it appears paradoxically. Think of the problems of artificial intelligence—the paradox, of trying to program an artificial mechanical mind, is that the fundamental product of the mind, the hypothesis, cannot be derived from anything that has come before and cannot be generated mechanically.

The paradox was that with Kepler's determination of time being measured by area, it became possible, given two positions of a planet, to measure the area, and thus the time, between the positions. But it was impossible to do the reverse—the exact location of a planet at a given time in the future was impossible to determine. The area involves both a circular arc (the measure for the portion of the circular section) and a straight line (the sine that is the measure for the triangle), two magnitudes that Cusa demonstrates are incommensurable (Figure 6).

The paradox that Kepler arrived at indicates that he did not get an answer, although he did. The unanswered incommensurability one arrives at when trying to determine position at a given time, is the answer. It is the only way that the universe, speaking through that mathematical system (Sensorium), could answer your question. A poet, passionately conveying a profound idea, cannot do so directly, but only through metaphor. When LaRouche answers your question in a way that seems to not answer it at all, it is precisely those questions in your mind that spring up that are the real substance of the answer.

Here, the substance of the universe's response to Kepler was a challenge, to which Leibniz responded with a higher-*power* mathematics based on principle: his calculus. His conception was to determine the principle of the unfolding of the differential (gravitation) to determine the integral (orbit) in a way that could generate, knowably, the desired location.

Leibniz's response, to the universe's response to Kepler, was another question; Leibniz was not successful in solving the Kepler problem, but his work laid the foundations for, and posed the questions to be answered by, the later developments of Gauss, et al. on the complex domain.

Invisible Principles

The development of the conceptions of universal least action and the infinitesimal calculus indicate much higher, metaphysical, principles than can be expressed as subjects of the language of geometry or physics. The hypothesis-of-the-higher-hypothesis implication of a principle of universal least action is the complete comprehensibility of the universe, as existing as the unfolding of physical principles, rather than a collection of sensory data.

You must look for invisible principles, not effects. Principle does not exist in properties of matter: ". . .always in its relationship to other objects, the primary, unmediated relationship between the particular and the universal subsumes and is the substance, of all relations to other objects."[2]

It's your universe: Take responsibility for it. The economy is bankrupt, your campus is losing money, popular entertainment is cruel, and a fascist beast-man is running your President. What do you think the universe is trying to tell you?

Notes

1. Johann Bernoulli, "On the Brachistochrone Problem," in David Eugene Smith, *A Sourcebook in Mathematics* (New York: Dover Publications, 1959), p. 652.
2. Lyndon H. LaRouche, Jr., "Project A," in *The Science of Christian Economy* (Washington, D.C.: Schiller Institute, 1991).

Chris Lewis

Youth at the cadre school in Mainz, Germany, December 2003, listen to Lyndon H. LaRouche (right).

Love and Politics: The Role of Communicating Subjective Ideas in Economics

by Randy Kim

MY OWN ORIGINAL DISCOVERIES OF 1948-1953, within the context of Leibniz's original (1671-1716) discoveries in the science of physical economy, were initially developed by my viewing technological progress as the outcome of those discoveries of universal principle which are situated within the domain of that notion of irony defined according to the principles of Classical artistic composition.

In other words, I rejected the contemporary, popularized division of academic knowledge into what British author C.P. Snow identified as a division between "two cultures," physical science versus the arts. I recognized a Classical form of irony (e.g., metaphor most emphatically), if it were truly Classical irony, as the complement to the paradoxes which promote the birth of discovered physical principles. Physical science, as usually viewed, pertains to the implicitly direct relationship of the cognitive powers of the sovereign individual mind to the physical universe. Classical art, especially Classical artistic irony, references the same kind of individual cognitive powers, but for the case that the immediate subject is the social process, rather than the individual's ostensibly simpler, presumably direct relationship to the physical domain.

I recognized, in a way reinforced by my subsequent study of Riemann's argument, that it is in the social dimension of cognition, that the individual forms those ideas for practice which are valid universal principles of physical science. Hence, the relative uniqueness of my discovery on this point.

—From "On the Subjects of Tariffs and Trade,"
Lyndon H. LaRouche, January 12, 2004

Wow . . . that's a handful to understand, but approachable. A real mind tickler is why Lyndon LaRouche would discuss the relationships between irony in classical art and irony in classical scientific discovery within a paper titled "On the Subjects of Tariffs and Trade"? Isn't that ironic?

There are a lot of unexpected surprises and ironies associated with this campaign, especially from the standpoint of someone who comes out of a nihilistic culture. Considering myself one of the "artsy types," the greatest irony I encountered, was the insistence upon Carl Friedrich Gauss's proof of the fundamental theorem of algebra, as key to understanding the folly of modern popular opinion. This must be done in order to prepare a society for a great challenge: To rebuild a world wracked by decades of post-industrial suicide and parasitical financial practices.

Science and the YOUTH MOVEMENT

But what makes any of this more substantial than what Professor Harry Potter has to say about economics? Why should these ideas move a man more than the ideas espoused by the academic world? How does someone measure how truthful an idea is? These are the questions that anyone serious, who joins the LaRouche Youth Movement, must encounter.

I learned very quickly that static ideas would not help me to recruit other young people; that only ideas in motion, working to change the current political, economic, and cultural situation, would hold any water with a generation fed up with the society they have inherited from a "baby boomer" generation which has given up on the future. This need to put ideas into motion has engulfed me in the greatest creative crisis in the 21 years I have been alive. I find myself, every day, having to confront and work with hundreds of different people, as the *only* way to effect real political change. My whole concept of identity, friendship, communication, and love, prior to the commitment to become a *real* human being, has been shaken from its foundations.

I think something of significance to note in my personal life, is that of the hundreds of people I knew as a child, and many of them which I considered to be my friends, the discussion of moving ideas and the need for revolutionary change in replacement of psycho-mimetic drugs and punk rock shows, led most of them to ostracize me from their lives and circles of friends. This to me is a very solid proof that what I, as well as most of my peers, regarded as friendship and love were completely wrong. What then is real friendship, and how do you really know another human being's mind?

These are some of the problems that the world's most powerful-per-capita political force is training its sights on. The answer to these, and similar questions, holds the key to understanding what culture and society are, how a political army of thousands will work, and how we will create and sustain a world Renaissance.

The Mainz Mission

Three months ago, I was sent overseas to help build a stronger European section of the LaRouche Youth Movement, along with several other Americans from California, Texas, New Jersey, and Maryland. I stayed primarily in Germany, and others went to other countries.

This was a completely new geometry for me, which forced me to reevaluate all of my assumptions about organizing the population and humanity to fight for civilization. New language, new culture, new history—everything was completely different . . . and yet something remained the same, which I will talk about later.

I saw the house in which one of the greatest scientists of modern history, Nicholas of Cusa, lived. I saw stone supports on the side of the road which were built by the Romans to transport water. I drank wine from a 2,500-year-old Etruscan goblet. I had never been outside the country before this trip. It was complete culture shock.

This was the kind of geometry I was in when I made the largest conceptual breakthrough since my joining the LaRouche Youth Movement full-time.

During the Christmas vacation (which in Germany means that *everything* stops), the LaRouche Youth Movement was completely transformed and put inside a productive crisis, when we got together for a seven-day cadre school. Now, many of you may not be too familiar with this concept of a cadre school, so a little bit of background is necessary to understand why this particular cadre school in Mainz, Germany, was such a breakthrough.

The original idea of the cadre school was to have an intense period of intellectual work, in which young contacts could get a sense of what the LaRouche Youth Movement is, the ideological basis of the political fight, and get more involved with the campaign. This was a great conception, but just as when Vice President Dick Cheney says the same thing about prewar intelligence at three different times with three different results (thanks to the hell Lyndon LaRouche has put him in), battle strategies must change and improve. No man steps in the same river twice.

Based largely on the hard work of youth organizers like Ludwig from Venezuela, Aaron from Los Angeles, Elodie from France, and Christoph from Germany, a plan was devised to have intense workshops known as "Monge Brigades," with very powerful presentations by Jacques Cheminade (candidate for the Presidency of France), Dr. Jonathan Tennenbaum (science advisor to Lyndon LaRouche), Bruce Director (Lyndon LaRouche associate leading the mathematical work with the Youth Movement), Helga Zepp LaRouche (wife of Lyndon LaRouche and candidate for the Chancellorship of Germany), and Lyndon LaRouche (candidate for the Presidency of the United States), to provide a conceptual anchor for more productive group work, instead of 70 hours of classes (however potent).

The way these things worked in the past, is that the cadre school would be class after class after class, and only the cigarette smokers and late-night sleepers would end up having provocative organizing-related discussions. You can imag-

EIRNS

The East Coast cadre school, Feb. 1-2, 2004, studying Bach's motet "Jesu Meine Freude," with Jenny Kreingold at the piano.

ine how many people end up slipping through the cracks, sleeping through the presentations, and being generally quite successful at avoiding the tension of really challenging truthful ideas.

Not so this time. The gathering was divided into four groups of 15 people, with each group having a good mixture of new people, old people, and everything in between. Four rooms were set aside. One for Carl Friedrich Gauss's proof of the fundamental theorem of algebra, one for Johannes Bach's motet "Jesu Meine Freude," one for Plato's "Meno" and "Theatetus" dialogues, and one for Friedrich Schiller's "On the Sublime."

Sounds pretty normal doesn't it? All four groups were to rotate through the rooms, spending about an hour and a half in each, with about six hours of intense Monge Brigade work a day. Afterwards came the presentations, with the most astonishingly developed questions and criticism centered upon the real creativity experienced in group work on a discovery.

Here's what happened: After a great blessing on the first day, given by Lyndon LaRouche, we woke up the second morning to get to work. We copied and stapled 16 "Meno" dialogues . . . and then the chaos started.

Social Processes and Productive Crises

Why do we have to read Socrates in groups? It's so slow and some people always interrupt and, and, and . . . Why indeed? If I were by myself I could read the "Meno" dialogue probably four times in an hour and a half. Why these "groups of no more or less than 15 to 25 people?"

There is no easy answer. You the reader must decide to uncover what the complex domain, where invisible scientific principles govern the sensory world, really is. In the domain of the Monge brigade, it becomes a startling creature, whose presence fills the whole room, and all individuals truly engaged sense its presence. It is examined. Its distinguishing characteristics are carefully noted. It travels around the room and it often appears out of the corner of one person's mind.

The Monge brigade ends and the creature seems to vanish. Over lunch the participants, like a group of excited biologists marvel at this new species never before observed. And then, you get back to the field and try to re-create the laboratory environment which facilitated the creature's appearance, and, sure enough, after some period he arises again.

This time you didn't even see where he came from, even though you were keeping your eye out for him. The creature seems to survive only in the environment of special social processes. Special, because the geometry in which the social process is embedded, is the *immediate* need for political change.

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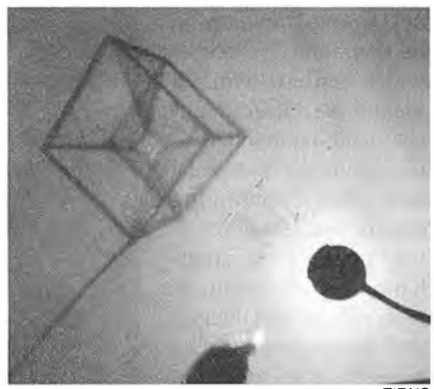
Looking at the least-action shape the soap bubble knows to take inside a cube, at the East Coast cadre school.



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A projection of the bubble onto a screen.

> The way the youth movement deploys, which the old—I won't say what they are—can't do, is that they have a sense of mission orientation. This is one of the reasons I wanted to keep the old folks away from them, because they would suppress them. They would tell them, you've got to do it in an orderly way, according to some rule. *No, No, No.* Let them apply the lesson of the Monge principle—in this case, the Gauss principle—and apply that lesson to what they're doing, because they're engaged in social processes, and social processes are inherently just as lawful as so-called physical scientific processes."
>
> —Lyndon H. LaRouche, January 10, 2004

The crisis we were facing in Mainz, was the confrontation of a social process none of us had ever seen before. "Seasoned veterans" found themselves in completely unknown territory. Many people remarked to me that they were thinking about ideas with a gravity they had not experienced since they contemplated joining the movement.

New people had the courage to speak up, disagree, lead key discussions in the brigade, and *join* the campaign! They were inspired by seeing members of the campaign who no longer seemed to be on an intellectual and moral pedestal; who were, instead, struggling to understand the enormously complex social dynamic created by a seemingly linear, simple hypothesis to actually *do* what Lyndon LaRouche has been emphasizing about the brigade system of rapidly assimilating ideas.

> I thought there was something wrong with a political organizer being challenged. I thought after you joined you would learn new things, but I didn't think we could be just as confused as new people. I didn't think we could undergo the same level of tension as we had when we joined. I thought tension is what new people are supposed to feel, and I certainly

didn't think political organizers were allowed to make mistakes or concede to having difficulty with the ideas of the campaign. . . .

—Political Organizer X

I learned more about some of the people in my brigade in one week than I have learned about some political organizers in six months. This must be why the French succeeded in defeating a three-front war after the French revolution of 1789 totally destroyed the foundations of the society. The French, under the leadership of men like Lazard Carnot and Gaspard Monge, created a rapidly developed and developing deployment force, which recruited while it fought: A cadre of leaders, teaching teachers to teach more teachers, and thus facilitating exponential growth.

I finally saw first-hand, the solution to problems which plague the development of a "many" (the different individuals in the campaign) into a "one" (the youth movement as a unity), with the added difficulty of constantly added new singularities (new political organizers) to the many.

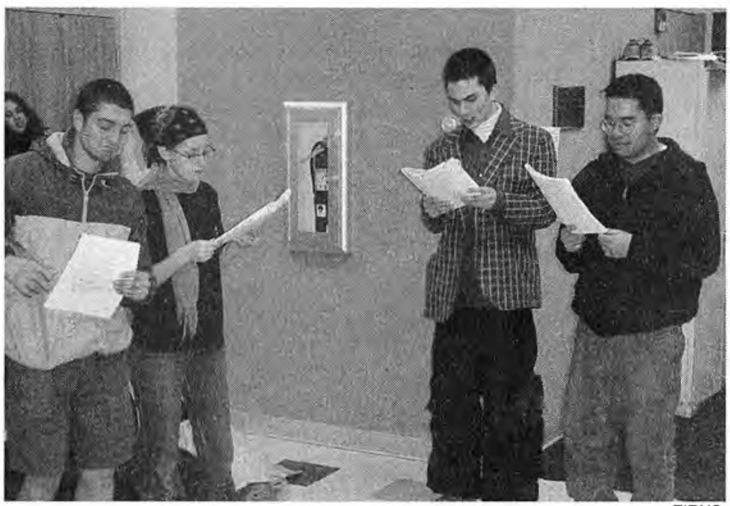
We need 10,000 youth movement members in a very short time. That means 10,000 individual, unique young people; 10,000 different personalities with different backgrounds and mannerisms; 100,000,000 peer-to-peer relationships; and a mind-boggling number of different group dynamics.

I have come to re-examine and reflect upon the crucial, often overlooked principles involved in group dynamics, and have found an immense sense of joy at being able to solve the problems I had had with different co-fighters for various irrelevant reasons, through these higher ordering principles of the "Monge Brigade."

Tension is not a bad thing! Having a crisis may be different from what you think it is. Social processes are lawful! Organizers can be organized (no matter how old they are), and communication may be a little more than talking *at* someone.

Gauss and the Social Mirror

Let's return to the subjects of irony and Gauss for a few minutes, in relation to this cadre school. Gauss has a wonderful tendency to provoke honest emotional responses from all manner of people, whether irrational, fearful, arrogant, or otherwise. I found that the Gauss was the most joyful and difficult brigade of the event, and that, as the event progressed, and discoveries and brigades were worked through on the other subjects, Gauss become more and more provocative.



EIRNS.

Reading through a Plato dialogue.

Does anyone even *know* what an algebraic rational integral function is?

—French organizer Clement on the title of Gauss's paper, "New Proof of the Theorem That Every Algebraic Rational Integral Function in One Variable Can Be Resolved into Real Factors of the First or the Second Degree"

Ah, yes. It's refreshing, how a new member can really stir up some trouble and call people's bluffs. Through the course of this particular brigade on the third day, the only people talking were contacts and new members, rarely asking for insight from older organizers, and even then sometimes having other new people insist upon discovering the particular answer themselves. The most amazing singularity in that brigade? The insistence by one person, who had been involved only one month, that we: "Shut up and stop talking about the paper! Why don't we actually try and read it!?"

During this amazing brigade, the four most senior organizers in the group hardly said a hundred words among the them. Only a few potent, strategic, thought-provoking questions were actually steering the conversation through rough terrain. I remember quite clearly, that after Clement asked his question regarding the title, Elodie and I looked at each other, and knew exactly what the other was thinking!

The social process Lyndon LaRouche describes, and the quality it possesses for illuminating people's minds to each other, was being proven. We smiled and returned to the paper, deciding that rather than expounding on what we thought we knew about Gauss, and extinguishing the positive tension, we would let the group stew (or simmer, as Elodie put it), and let them try and figure it out on their own.

This is what Lyndon LaRouche had told me in Germany during Christmas, when I had asked him about the difference between the poet Edgar Allen Poe's ability to analyze man, and the assumptions made by some, which lead to mistrust and categorizing. He said that in order to know another man's mind, one must furiously investigate his own. Can this be true vice-versa?

. . .In that process, you're able, in a sense, to look at yourself in the mirror of the minds of other persons—that's how you see yourself. In other words, when you see what you're trying to think through—but it's on the tip of your tongue, but you don't see it quite—when you see that taking shape in the mind of another person, in the process of a dialogue, now you're able to see yourself, as in a mirror. You're able to see your mind, as in the mirror of a social process. And that's the way it actually works.

> People who do enough, are able to synthesize that, that is, when they're thinking, even by themselves, are able to think in terms of a dialogue process. And be able to see themselves in a mirror. . . .
>
> —Lyndon LaRouche in an answer regarding the preconscious, at a cadre school in Los Angeles, January 24, 2004

This is the complex domain of social processes, and I am certain we are only just beginning to examine and enjoy the wonderful peculiarities of this.

> These investigations lead deeply into many others, I would even say, into the Metaphysics of the theory of space, and it is only with great difficulty that I can tear myself away from the results that spring from it, as, for example, the true metaphysics of negative and complex numbers. The true sense of the square root of negative one stands before my mind fully alive, but it becomes very difficult to put into words; I am always only able to give a vague image that floats in the air.
>
> —Carl Friedrich Gauss, December 11, 1825

The Most Powerful Per-Capita Political Force on the Planet

Thanks to a remarkably insightful youth movement in America, and a "few" phone calls by the Americans overseas to home base, the cadre school on the East Coast, which I attended immediately after returning from Germany, was highly successful. The most important thing? It was *completely* different from the Mainz cadre school.

Sure, the predicates were nearly the same. Approximately 15 people in each brigade and four different subject matters under examination. But, the members who planned the event were wise enough to understand that the Mainz cadre school involved an unseen principle which generated the results of the event, and to repeat the same hypotheses, in an entirely different geometry, would be like an act of the Cheney Administration. I urged everyone to be a scientist and to make his own hypotheses, and to test them instead of trying to replicate anything they thought happened in Mainz.

Science and the YOUTH MOVEMENT

It turns out that I didn't have to really urge at all, as everyone there had grown by leaps and bounds while I was away in Germany, and it was as if I had come back to a different organization. I had to learn who everybody was again . . . and what better situation could I have possibly asked for to do that, than this cadre school!

I found myself at times so pleasantly shocked by the progress of my fellow fighters, that I would just sit and listen to the process unfold. From the very first brigade, in which Larry (a youth organizer in Washington, D.C.) made an amazing connection between the drama "Julius Caesar" by Shakespeare, and the art of making a successful political intervention, followed immediately by Jenny's intervention on the nature of organizing the population, I tried not only to see the truthfulness of what was said, but the personality from which the insight was coming.

In a beautiful irony, the phenomenon of silent communication happened again within the context of a provocative Plato reading, after Zack had decided to interrupt business-as-usual, and raise a ruckus over the more important issues at hand—not the particular dialogue, but the geometry within which the dialogue and the Socratic Method are a part. Delante had quickly taken advantage of Zack's potent intervention, with Ashley and Jenny on board for the ride as well, by asking, "What is pedagogy?" And watching as the process unfolded from that question, Delante and I looked at each other in the same knowing way as had happened during the Gauss brigade in Germany, and returned to the conversation.

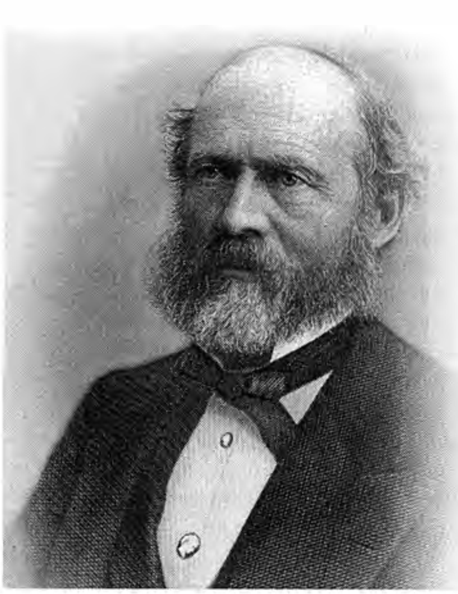
The reader is probably realizing by now that I haven't said much concerning the actual substance of the brigades: the discoveries made about the particular subject, diagrams concerning algebraic functions, the musical score we worked on, or how much of the Schiller piece we completed. This is intentional. You, the reader, must understand the necessity for this combat university on wheels, by joining our youth movement (your age doesn't disqualify you; it's your state of mind).

You can't experience these Monge Brigades outside of this movement, by the sheer fact that this is the only organization in which the unification of intellectual disciplines meets the frantic calls of reality. (Try studying Martin Luther King in a university where all the manual labor is accomplished by minorities; it seems somewhat superficial to allow a valid social process, eh?) Otherwise, the ludicrous behavior of our elected officials around the world, and the suicidal denial by popular opinion of the rapidly disintegrating economy, will plunge humanity into a dark age.

Don't kill science by separating it from humanity. Don't block on the need to investigate social relations, because the success of Lyndon LaRouche's economics, and the survival of modern civilization, depend on our successful transmission of these ideas into society. Maybe I wrote in this way because, in all honesty, I'm not sure if I've discovered exactly what this brigade thing is that we're dealing with. But I'll tell you what. We sure as hell will, because the answer will save humanity, and that . . . is fun.

> You get a bunch of friends around, with whom you have these dialogues, the constructive dialogues, and you find you want to go to meetings at which this kind of experience occurs. And you are very happy with those collections of friends, because there it happens. You get to know each other in a new way. You get to know yourself, you can anticipate the way they're going to react, each individual reacts in a different way. You get into a mood about laughing about the way people are predictable. And they laugh at themselves, the way they find themselves being predictable. And this is where this sense of beauty come in.
>
> It's just, what we're doing, is trying to create those kinds of social circumstances, especially among people between 18 and 25, in the years when people feel like adults, but they also feel young enough to be open to thinking afresh about ideas. This is the best kind of social relationship to have, out of which the better social relations later in life will come.
>
> —Lyndon LaRouche in an answer regarding the preconscious at a cadre school in Los Angeles, January 24, 2004.

Lewis Henry Morgan And the Racist Roots of Anthropology



Rochester Historical Society

clipart.com

Morgan (1818-1881) aimed to preserve the romance of the Indians from contamination with anything that might give them economic progress.

by Paul Glumaz

The concept of a "Native American" is a racist and mythological identity, intended to justify an Anglo-American empire.

Our story begins with the American founder of Cultural Anthropology, Lewis Henry Morgan.

Lewis Henry was born in upstate New York in 1818. By the 1840s, he was a young lawyer and Freemasonic activist who created a special lodge and Freemasonic rite for local young masons called *Inindianation.* Local youth would dress up as Indians, get initiated as braves, and run the gauntlet, all under the auspices of the local Freemasonic lodge. Throughout this period of the 1840s, Morgan was in correspondence with historian Henry Schoolcraft. Schoolcraft was an associate of Albert Gallatin, who at that time headed the New York Historical Society.

Gallatin, a scion of Swiss nobility, had been Secretary of the U.S. Treasury under Thomas Jefferson, and as amply documented[1] led the treasonous economic subversion of our young Republic in the early 1800s. This same Gallatin spent the last 15 years of his life seeking to shape the historical identity of pre-Columbus Americans. He sought through all means to establish that all pre-Columbus Americans were exclusively of Asiatic or Siberian origins. In other words, all Americans prior to Columbus had their origins in migrations by land, across Siberia, through Alaska, and down through the rest of the Americas.

With modifications over time, this view of the origins of all pre-Columbus Americans is still the prevailing view in Anthropology today. The current orthodoxy on the subject is that these Siberian migrations started 12,000 to 16,000 years ago, before which there were no human inhabitants in the Americas.

While Albert Gallatin sought to show this through the study of linguistics, Lewis Henry Morgan sought to show this through the comparative study of kinship, or family structures.

Why would the exclusively Siberian migration thesis be so important from the standpoint of someone like Gallatin, who was committed to the treasonous subversion of our Republic? Why?

The motive for this is racism.

Establishing the exclusive Siberian origins of pre-Columbus Americans had the principal intent of inducing in America, a profoundly racist worldview, including the justification of a very brutal treatment of descendants of pre-Columbus Americans. This, I am sure, is not immediately evident to the reader, but when this idea of the exclusive Asiatic origins is combined with still-prevalent views on social evolution, one has the makings of a very racist worldview. This worldview denies a universal human identity to the descendants of pre-Columbus Americans and, by extension, denies the same to the descendants of later European immigrants.

The racism generated by the enslavement of Africans as it currently affects our society is better known and studied today. The racism created by the discipline of Anthropology is more insidious, universal, less understood, and not studied.

What follows is a summary of how this works, using as a reference point the work of Lewis Henry Morgan.

The issue at the center of this is how societies evolve culturally, technologically, and economically. The racist idea is that societies evolve through gradual improvements that are diffused slowly from one individual and group to another. In this view, social evolution is gradual, and there is a gradual transition from hunting and gathering societies to modern industrial society.

These changes accrue through accidental and incidental inventions and innovations that accumulate over long periods of time. Some societies are better than others in this process, and some racial groups, too, are also better than others in this process. Lewis Henry Morgan's first discussion of this matter is in his monograph on the Iroquois Indians, *League of the Iroquois.* In this document, and later through other writings, Morgan developed some of the following theories, which were also being formulated more extensively by other anthropologists in Great Britain:

(1) Social and technological evolution is gradual.

(2) Not all societies develop at the same rates.

(3) Some societies are superior because of their racial stock, and have thereby developed superior social and family institutions.

(4) It is wrong to change or improve the lesser races because they are not mentally equipped for it. They must develop at their own rate.

(5) Protecting them from losing their primitive ways is the burden of the superior races.

(6) America's then-evolving superiority as an industrial nation did not rest on its deep cultural heritage in previous renaissances in Greece, the Arab world, China, and Europe, nor in the industry and freedom of its Republican citizenry, but instead on its special mix of Anglo-Saxon racial traits and superior family institutions.

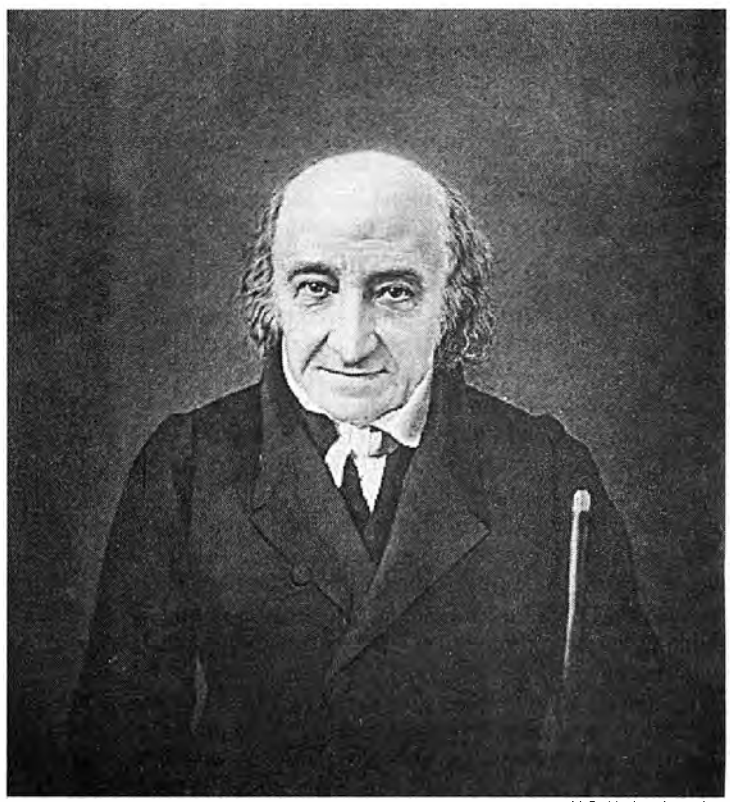
In Morgan's own words:

> The Aryan family represents the central stream of human progress because it has proved its intrinsic superiority by gradually assuming control of the earth. . . . The passion of the Red man for the hunter life has proved to be a principle too deeply inwrought to be controlled by efforts of Legislation. . . . The effect of this powerful principle has been to enchain the tribes of North America to their primitive state. . . . We have here the true reason why the Red man has never risen, nor can ever rise above its present level. . . . At this point the singular trait in the character of the Red man suggests itself, that he never felt the power of gain. This great passion for civilized man never aroused the Indian mind. It was doubtless the great reason for his continuance in the hunter state, for the desire of gain is one of the earliest manifestations of [the] progressive mind. In a word it has civilized our race.[2]

Morgan's explanations for successful social change and economic development boil down to two causal factors: racial characteristics and greed. The less economically developed societies are so because they lack the greed instinct, and they are genetically inferior perhaps because of this lack. Unfortunately, today, a vast number of Americans unthinkingly assume this to be the cause of the disparity in living standards between the United States and Third World nations.

Who Are We?

Despite the theories of Morgan, Gallatin, and their British counterparts, there exists much evidence, which has escaped suppression, from both archaeological and other sources, that



U.S. National Archive

Albert Gallatin (1761-1849), the Swiss financier, spent his early years subverting the young American Republic, and his later years inventing an ideology for the Siberian origin of American Indians.

significant urban and agricultural civilizations existed at various times and places in pre-Columbus America. Because such evidence was considered a threat to this racist worldview, Morgan spent much of his later life with an archaeologist, Adolph Bandelier, seeking to show that these earlier urban remains did not represent societies that were in any way developed.

On the question of the exclusive Siberian origins of pre-Columbus Americans, more needs to be said. To have any other explanation opens up a Pandora's box of issues that profoundly challenge the accepted views of prehistory and the origins of civilizations that are still taught in the schools today. How did they—the pre-Columbus Americans—get here? Were they here from the beginning? What about ocean travel in boats by sea peoples? Or migrations by boats from Asia? From Africa? From Iberia and the Mediterranean? From Northern Europe and Scandinavia?

Once you begin to examine the evidence that maritime civilizations and cultures existed long before Mesopotamia, and that astronomy and sea travel long predate the development of river valley civilizations, and that the remains of these maritime cultures are only now beginning to be found underwater off the coasts of India, the Caribbean, and other places, the exclusive Siberian origins theory is seriously challenged.

If maritime culture and ocean-going travel date back to 10,000, 40,000, or even 100,000 years ago, no part of the world is immune from colonization, trade, or from major cultural exchanges. This challenges the very racist concept of "natives" versus the more recent arrivals.

Why is this so important? Because it is an issue of *identity.*

Who am I? Where did we come from? What is a human being? Where do our cultures come from, or what remains from the past?

Are we a product of race, blood, and soil, or rather of a multi-layered process of the ebb and flow of cultural renaissances and migrations, as well as human and natural catastrophes? A secondary feature of this is the still prevailing orthodox idea that civilizations had their exclusive origins in the cradles of a few river valleys like the Nile, the Tigris and the Euphrates, the Indus, or the Yangtze in China.

In all these cases there is evidence that these cradles may have been spun off from more extensive and much older maritime civilizations, which have risen and fallen, in conjunction with other inland migrations and cultural exchanges. This indicates an origin of civilization that is much, much earlier, and more complex, than the idea of cradles 5,000 to 7,000 years ago. If you challenge the exclusive Siberian origins of pre-Columbus Americans, you are also implicitly challenging the orthodoxy of the cradles theory of the origins of civilization.

In effect, you are challenging the very root of our historical identity in antiquity. It is the means of inducing an identity based on race, blood, and soil as the primary determinant of civilization and culture, which is most useful in controlling one's sense of "I and We," as well as of "They."

The truthfulness of human origins is subordinated to the necessity of a mythology that generates identity. The entire concept of Native Americans is a racist and mythological identity intended to justify an Anglo-American empire. It is to promote such mythologies as science, that the discipline of Anthropology was originally created. Regrettably, this is still playing out in a most dangerous crisis to civilization today.

The Young Indians

America's founding fathers were steeped in the classical culture of both ancient Greece and the Renaissance in Europe. They saw themselves in world historical terms: as fulfilling, in the creation of this Republic, a way of liberating the world from the dominance of feudal and financial oligarchies that in one way or another enslave 95 percent of the population to being less than human. To attack this classical culture of our founding fathers, a Romantic movement was launched in Europe. This Romantic Movement is best represented in the English language by the work of authors like Sir Walter Scott, promoting a love for and revival of a barbaric feudal past. An example in the German language is Richard Wagner, who promoted a similar barbaric Romantic past of Teutonic myths and legends that became the cultural substratum of Hitler's Reich.

Because we had no such feudalist precedents in America, when this Romantic Movement spread here, it chose the Indian as its first theme, and then later the Cowboy. Lewis Henry Morgan was involved in this process in the middle 1840s.

In 1845, Morgan wrote to Britain's leading Indianologist, William F. Stone, who had written *The Life and Times of Red Jacket* (Red Jacket was an Iroquois leader):

> We need somewhere in our Republic, an Indian Order. Such an order would have a vast and novel field of literary research, the romantic age of the western world. Indian life suggests ample material for the philosophic, poetic . . . and distant generations must look back to the Indian Age for the babble, the antiquities, and the romance of America. The nature and object of our order is of course secret from the world.[3]

From Morgan's perspective, the romance of the Indians had to be preserved from contamination with anything that would give the Indians economic progress. A campaign to make Lewis Henry Morgan head of the Bureau of Indian Affairs, during the first term of President Lincoln, failed. With the Indian Bureau, at the time, enveloped in corruption scandals, Morgan led a campaign to reform the Bureau, and made the following proposals to Lincoln, in a letter dated December 3, 1862:

> (1) Put the Bureau under the War Department.
>
> (2) Stop appropriations for Indian agricultural programs in the West which interfere with the Indian way of life there, in that the Plains Indians should be herders not farmers.
>
> (3) Gather all Indians into two locations, one in the West, and the other in upstate New York in the East.
>
> (4) Institute strict control of contact between the Indians and the outside world by appointed missionaries, and forbid the monetary circulation amongst the Indians.

There is much evidence of ancient cultures existing in America prior to 12,000 years ago, although it has been denied, suppressed, or ridiculed. The American geographer George F. Carter has documented evidence in North America of tools, fireplaces, and other artifacts of human life dating back 100,000 to 200,000 years. This photo shows sea cliffs on Santa Rosa Island, off the coast of California. The arrow (upper left) points to a man standing on the level dated to 12,500 years ago. On the level below him, Carter writes, "are traces of man's fireplaces and, in huge pits, barbecued elephants. One of these dated to almost 30,000 years ago."

Source: Photo by Phil Orr in George F. Carter, *Earlier Than You Think: A Personal View of Man in America* (College Station, Tex.: Texas A & M University Press, 1980), p. 50.

(5) Promote native handicrafts to promote a romantic appreciation for the Indian race and its heritage.[4]

It is no coincidence that today a similar point of view is common among too many people who consider themselves knowledgeable of cultures in the Third World. In this view, it is believed that preserving Third World populations in their cultural purity is preferable to letting them attain industrialization. This view is a form of Romanticism, in which Morgan's work with the Indians was an earlier precursor.

Morgan's work combines both the racist and Romantic view of the Indians. This is not a paradox. Romantic culture rejects science and truthfulness for the enthrallment of appearances, the deification of distinctions, and the mystification of the arbitrary. Alongside of this Romanticizing of the Indian is the Romanticizing of the Cowboy.

The original Cowboys in reality were convicted criminals sent to the West to save the government the expense of incarceration. Later, displaced Confederate soldiers who became outlaws, drifted into the West after the Civil War to become Cowboys. Today a synthetic, anti-intellectual, romantic, simple-minded cowboy identity has become very popular in our culture. This, and the conception of our Indian heritage, alongside the "lost cause" theme of the Confederacy, are the principal American products of a Romantic movement launched in Europe to destroy the creative and Promethean identity of America, and the classical culture of our founding fathers.

The Nature of Man, Slavery, and Environmentalism

Central to the core of Anthropology is the question, What is a human being?

What makes human beings different from the animals? Why are human beings able to establish through science and culture a population on this planet of more than 6 billion? During the 1860s, there was a deeper philosophical political debate occurring on this question, not just on the question of slavery itself, but also on the deeper issue behind the issue of slavery: What is the essential nature of human beings?

If there is no basic difference between the human species and the animal species, then, on a deeper level, because differences between animal behavior and capabilities are considered to be innate (later called genetic), differences in such matters between human individuals and social groups (societies) can also be considered innate, or genetic.

One cannot say *there is no fundamental difference* between human beings and animals, without also maintaining a racist view on the causality of distinctions between individuals and societies. The denial of the absolute distinction between human beings and animals provides the deeper axiomatic root for a racist worldview.

This view will always justify the enslavement of one people by another on the basis of their differing inherent traits.

The philosophical root of this view is deeply embedded in the empiricist and positivist philosophical tradition that has become dominant in modern times. It could be said that Cultural Anthropology is one of the by-products of this tradition. The empiricist and the logical positivist cannot distinguish between the creative products of the human mind, and the instincts of the brutes. President Lincoln addressed this deeper issue in his favorite campaign stump speech in 1860, "On Discoveries and Inventions":

> All creation is a mine, and every man a miner. The whole earth, and all within it, upon it, and round about it, including himself, in his physical, moral, and

intellectual nature, and his susceptibilities, are the infinitely various leads from which, man, from the first, was to dig out his destiny. In the beginning, the mine was unopened, and the miner stood naked, and knowledgeless, upon it. Fishes, birds, beasts, and creeping things, are not miners, but feeders and lodgers merely.

Beavers build houses; but They build them in nowise differently, or better now, than they did, five thousand years ago.

Ants and honey bees provide food for winter; but just in the same way they did, when Solomon referred the sluggard to them as patterns of prudence. Man is not the only animal who labors; but he is the only one who improves his workmanship.

This improvement he effects by Discoveries and Inventions.[5]

Lewis Henry Morgan entered this debate not merely on the other side, but more: he sought to raise animals to co-equal status with humans. He spent every summer from 1855 to 1868, studying the beaver in northern Michigan. His book, *The American Beaver,* sought to prove that animals had all the faculties of human beings, but to a lesser degree. He accused those who shared Lincoln's view of being guilty of an erroneous, man-centered egoism. He said they had created a fraud on the animal races, by defaming animals as instinctual, rather than having a mind like human beings, but of a lesser degree.

Morgan's proposals to President Lincoln for the reform of the Bureau of Indian Affairs would have put the Indians into a kind of "zoo," to keep them isolated, and romantic.

Morgan responded to the idea expressed by Lincoln in his speech quoted above, just quoted, by saying that the lack of material improvement in successive generations of animals is the result of the fact that animals

generally require no artificial means to promote their happiness, nor do they have the gregarious principle to the same extent as it is in man. . . . A scale of intelligence from man to the most inferior animal appears to result as naturally as a scale of intelligence among men founded in their differing characteristics. . . .The same thinking intellectual principle pervades all animated existences; created by the Deity and bestowed in such measures upon different species as appeared in His wisdom requisite for the destiny and happiness of each.[6]

Later in life, in the late 1870s, Lewis Henry Morgan succeeded Sylvester Morse as the President of the American Association for the Advancement of Science. From this position, Morgan played a seminal role in launching what would later become the Conservationist and Environmentalist movements. Morgan saw preservation of the environment in much the same way as he saw preservation of the Indians.

The Newton of the Social Sciences

In 1871, Lewis Henry Morgan published a huge tome titled *Systems of Consanguinity.* This was the result of more than a decade of examining questionnaires sent back by missionaries and others, working with Morgan, concerning the way various peoples designate their kin, and the rules governing relations between lineage and kin, in terms of who to marry, who not to marry, and so on. These were the original kinship studies that today are the stock-in-trade of Cultural Anthropology.

At first, Morgan did not have a way of creating a general evolutionary theory from the data, as he had first intended. Originally, he was going to use this data to prove that pre-Columbus inhabitants had migrated via Siberia and Alaska. He thought this would be evident from common patterns in the way pre-Columbus descendants designated their kin, compared with groups of people from Europe, and other areas. This proved impossible, and Morgan spent eight years rewriting and trying to make sense of the data.

Finally his spiritual advisor, Reverend Joshua McIlvanie, a Princeton professor of Orientology, used quotes from Aristotle to convince Morgan to adopt the evolutionary point of view of John McLennan and Sir John Lubbock of Britain, whose ideas are developed out of Thomas Malthus, Charles Darwin, and Thomas Huxley. The basic schema of Mclennan and Lubbock, which Morgan embraced (despite a big spat with McLennan over some of this), is as follows: Food scarcity at the dawn of mankind led to infanticide of females, and this, in turn, led to shortage of wives and a struggle for capturing wives. This then led to polyandry, a system of shared wives by a family of brothers.

Then, the schema holds that somehow there was a revolutionary improvement that led to the formation of patriarchies based on polygamy, as in the Old Testament. This is followed by another revolution, which leads to monogamy and patrilinear descent of property. Monogamy and patrilinear descent then set the stage for the rise of modern property relations, which is the backbone of—yes—capitalism.

To this scheme, Morgan, in his later tome, *Ancient Society,* adds the final stage of this development: the emergence of some kind of socialism where communal property relations re-emerge, with perhaps new kind of sharing of wives.[7] This appealed greatly to Karl Marx's leading collaborator, Frederick Engels, who wrote a book based on Morgan's work, titled *The Origins of Family, Private Property, and the State in Light of Researches of L.H. Morgan.*

Morgan, after the publication of his book *Systems of Consanguinity* in 1871, went on a high-profile tour of Europe.

There he met with Charles Darwin, Thomas Huxley, and Herbert Spencer, and was hailed as the Newton of the Social Sciences. Not only did Frederick Engels embrace Lewis Henry Morgan, but Daniel DeLeon, the head of the Socialist Party of America, used Morgan's *Ancient Society* as a political bible.

New World Archaeology or The House of Montezuma

In the 19th Century, there was much interest in the question of what kind of civilizations had existed in the Americas before Columbus. Central in this are the chronicles of the early Spanish explorers, which describe large urban centers in Mesoamerica as well as the Andes. Historian Hubert Bancroft, a very influential figure who wrote popular histories on the native races of the Americas, greatly acknowledged these accounts of the early Spanish explorers. Henry Adams wrote to Lewis Henry Morgan that it was an embarrassment to serious scholarship that these early Spanish chroniclers were taken seriously, and that something had to be done.[8] Morgan responded with a campaign against Bancroft's use of these chroniclers, claiming that these early Spanish chroniclers exaggerated in order to impress the Spanish Court.

Morgan claimed that all the aboriginal races of the continent have a family caste, and that Montezuma was one of the large number of Sachems (or chiefs).[9] In Morgan's article "The House of Montezuma," he tries to prove that the Aztecs, and others, were no different in their basic development than the natives one encountered in the United States. To help him in this, and to gain control of New World Archaeology, Morgan recruited a young Swiss immigrant, Adolph Bandelier, whom he first met 1873.

Earlier, as a student at the University of Berne, Switzerland, Bandelier had been influenced by the networks of Alexander von Humboldt to study the history of Spanish America, and master indigenous languages. Realizing that Bandelier had the ability and the knowledge, Morgan sought to prove through him the eternal primitiveness of the indigenous inhabitants of all of the Americas. Although Bandelier was in awe of Morgan's reputation, he could not agree with Morgan's notion that civilization never existed in the New World until the advent of the Europeans.

President Lincoln Vs. Morgan On the Difference Between Man and Animal

Library of Congress

Abraham Lincoln addressed the issue of man vs. beasts in his favorite campaign stump speech in 1860, "On Discoveries and Inventions":

> All creation is a mine, and every man a miner. The whole earth, and all within it, upon it, and round about it, including himself, in his physical, moral, and intellectual nature, and his susceptibilities, are the infinitely various leads from which, man, from the first, was to dig out his destiny. In the beginning, the mine was unopened, and the miner stood naked, and knowledgeless, upon it.
>
> Fishes, birds, beasts, and creeping things, are not miners, but feeders and lodgers merely.
>
> Beavers build houses; but they build them in nowise differently, or better now, than they did, five thousand years ago. . . . Man is not the only animal who labors; but he is the only one who improves his workmanship.
>
> This improvement he effects by Discoveries and Inventions.

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Lewis Henry Morgan, like many environmentalists today, took the opposite position, and in his book, *The American Beaver,* he tried to prove that animals had all the faculties of human beings—but to a lesser degree. Those who shared Lincoln's view, he said, were man-centered egoists:

> A scale of intelligence from man to the most inferior animal appears to result as naturally as a scale of intelligence among men founded in their differing characteristics. . . .The same thinking intellectual principle pervades all animated existences; created by the Deity and bestowed in such measures upon different species as appeared in His wisdom requisite for the destiny and happiness of each.


ANCIENT SOCIETY

RESEARCHES IN THE LINES OF HUMAN PROGRESS

FROM SAVAGERY THROUGH BARBARISM

TO CIVILIZATION

LEWIS H. MORGAN, LL.D

NEW YORK

HENRY HOLT AND COMPANY

1878

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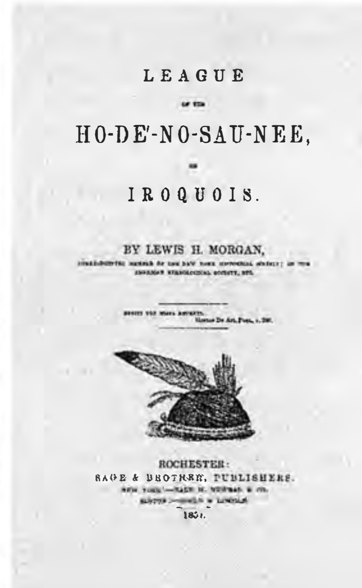
LEAGUE

HO-DE'-NO-SAU-NEE,

IROQUOIS.

BY LEWIS H. MORGAN,

ROCHESTER:

SAGE & BROTHER, PUBLISHERS.

1851.

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"This great passion for civilized man [greed] never aroused the Indian mind," wrote Morgan, the "Newton of the Social Sciences," in his book glorifying the communal life of the Iroquois, League of the Ho-De-No-Sau-Nee, *or Iroquois. Here, title pages from two of Morgan's book, and a 1911 drawing of an Iroquois.*

For six years, Bandelier corresponded with Morgan and hoped for the reward of being recognized by the Peabody Museum and having his work published.[10] He had a lot of doubts about Morgan's thesis, but seeking to escape the circumstances of his undistinguished existence, he was gradually won over to Morgan's point of view. After that, many doors opened to him, enabling him for the next 35 years to pursue archaeological work in New Mexico, Mexico, and Peru. During this period he was loyal to Morgan's claims, and he downplayed the level of development of pre-Columbus Americans.[11]

From Lewis Henry Morgan to Margaret Mead

The road from Lewis Henry Morgan to the cultural anthropologists most known today, like Margaret Mead, is virtually a straight line. Later in life, Morgan's most important collaborator was Frederick Ward Putnam. Putnam was curator of the Peabody Museum in Massachusetts from 1874 to 1909. The Peabody Museum was a principal source of funding for archaeological digs and ethnographic studies, and is the main institution that promoted the establishment of the discipline of Anthropology, over the objections from the academic community of that time. This Museum was established by the Peabody fortune, which originally was made in the opium trade in partnership with the British East India Company. (The founding Peabody later moved to London, and upon his death, Junius Morgan, his junior partner, became his sole inheritor. Junius Morgan is none other than the father of the financier J.P. Morgan.)

In the last decade of Lewis Henry Morgan's life, Frederick Ward Putnam spent as much as one month each year sojourning with Morgan at his home, and was his most frequent correspondent. From 1873 to 1898, Putnam was also the Permanent Secretary of the American Association for the Advancement of Science, the association of which Lewis Henry Morgan, later in life, became the President.

At the end of the 19th Century, Putnam succeeded in establishing at Harvard University, the first Department of Anthropology in the United States. At that time, Cultural Anthropology was not considered by most to be a rigorous science, and there was much opposition to its establishment as an academic discipline. Later on, at the beginning of the 20th Century, Putnam was successful in establishing an Ethnology Department at the American Museum of Natural History in New York City.

It is not a coincidence that the American Museum of Natural History is also one of America's principal institutions promoting the racist science of Eugenics. From the American Museum of Natural History, with the help of Putnam, a professorship of Anthropology was subsequently established at Columbia University. Putnam personally recruited a Swiss physicist, Franz Boaz, for this post. It is Franz Boaz (1858-1942) who was the teacher of Margaret Mead, Ruth Benedict, Melville J. Herskovits, Alfred Kroeber, and other anthropologists well known today.

Boaz is the one who introduced one of the most prominent ideas in Cultural Anthropology: cultural relativism. Simply put, cultural relativism is the idea that a culture cannot be judged by an Anthropologist, as good or bad; or more developed, or less developed. Each culture, according to cultural relativism, has its own ways and can be judged only from the standpoint of the culture itself.

If cannibalism and infanticide, therefore, are practiced by a particular society, it is right for that society, and the Anthropologist has no right to consider these practices as wrong or barbaric, because they are practices that belong to a different culture. This idea, while appearing to be a departure from the more overt racism of Lewis Henry Morgan, is nonetheless a racist concept, in that it denigrates individual members of a culture to the status of members of different theme parks in a big zoo. The more such theme parks that can be studied, before they become economically, and culturally contaminated by global civilization, the more we supposedly learn about what it is to be human. Yet, these primitive cultures that are studied, and often so romanticized, are generally mere fragments, or remnants of vaster civilizations that had undergone a collapse.

In truth, there is no such thing as primitive cultures. This is a racist conception. If a society appears primitive, it is because it has lost most of the culture it was once a part of. Whatever kind of culture that is encountered and considered primitive, is rather a fragment of a window into the past of some more developed civilization, or of a group influenced by and peripheral to such a civilization. The greatest damage that modern Cultural Anthropology has done has been to divorce the history of a people from the study of the same people.

This is where racism and romanticism converge. The fact that a written history or oral history of such a people may not exist, or that any knowledge of such a history may not exist, does not mean that the society had no history.

For many years, the champion of cultural relativism, Margaret Mead, worked for the U.S. Military in training special forces in cultural counterinsurgency. Mead's greatest accomplishment was not her well-known *Coming of Age in Samoa* book, in which she claims to have discovered the now famous institution of Samoan premarital sexual promiscuity. (This discovery of hers is all the more remarkable because no Samoan ever knew such an institution existed, and all subsequent ethnologists can only verify that Samoans are among the most strict and puritanical of societies about such matters.) Rather, Mead's most influential work was with her sometime husband, the psychologist Gregory Bateson, in helping to create the greatest cultural counterinsurgent movement of all time, the Rock-Drug-Sex-Counterculture. Mead's idea was to have an entire generation emerge without any historical connection to the vast universal and multi-geographical history and culture of their parents and grandparents.

Jack Manning/NYT Pictures

A tribal witch? No, it's Margaret Mead, mother of the counterculture, at 75.

Through this Rock-Drug-Sex-Counterculture, the individual would be induced to locate his or her identity, primarily in varied sensual existences and feeling states, not in history. The intent here was to create a new kind of savage, one who merely lives day to day, without history. Perhaps we could say that our current "no future" culture is in part, shaped by Cultural Anthropology. The same could also be said about how we think about ourselves as human beings.

And so, the racist roots of Cultural Anthropology are very much with us today.

Paul Glumaz is a full-time organizer with Lyndon LaRouche's political movement. In the late 1960s and early 1970s, he studied Cultural Anthropology at Columbia University in New York City. In the late 1970s, he had access to the personal letters of Lewis Henry Morgan, in Rochester, N.Y.

Notes

1. See Anton Chaitkin's book *Treason in America* (Washington, D.C.: Executive Intelligence Review, 1998).
2. Lewis Henry Morgan, 1922. *League of the Ho-De-No-Sau-Nee, or Iroquois* (New York: Dodd and Mead), p. 54.
3. Bernhard J. Stern, 1931. *Lewis Henry Morgan, Social Evolutionist* (Chicago: University of Chicago Press), pp. 13-14.
4. Carl Resek, 1960. *Lewis Henry Morgan, American Scholar* (Chicago: University of Chicago Press), p. 83; pp. 144-45.
5. W. Allen Salisbury, 1978. *The Civil War and the American System* (New York: Campaigner Publications, Inc.), *p. 217.*
6. *Stem (Note 3), p. 101.*
7. *Stem (Note 3), p. 92.*
8. *Lewis Henry Morgan, 1877. Ancient Society* (New York: H. Holt & Co.), pp. 488-499.
9. Stern (Note 3), p. 115.
10. Leslie A. White, 1940. *The Bandelier-Morgan Letters, 1873-1883. Pioneers of American Anthropology,* Vols. 1 and 2, p. 1.
11. Stern (Note 3), pp. 109-112.

Putting Atoms for Peace Into Practice

by Douglas M. Fouquet,
Junaid Razvi, and
William L. Whittemore

For 45 years, these small, inherently safe nuclear research reactors, based on an idea by Edward Teller, have been training nuclear workers and supplying isotopes and neutrons for medical and industrial use around the world.

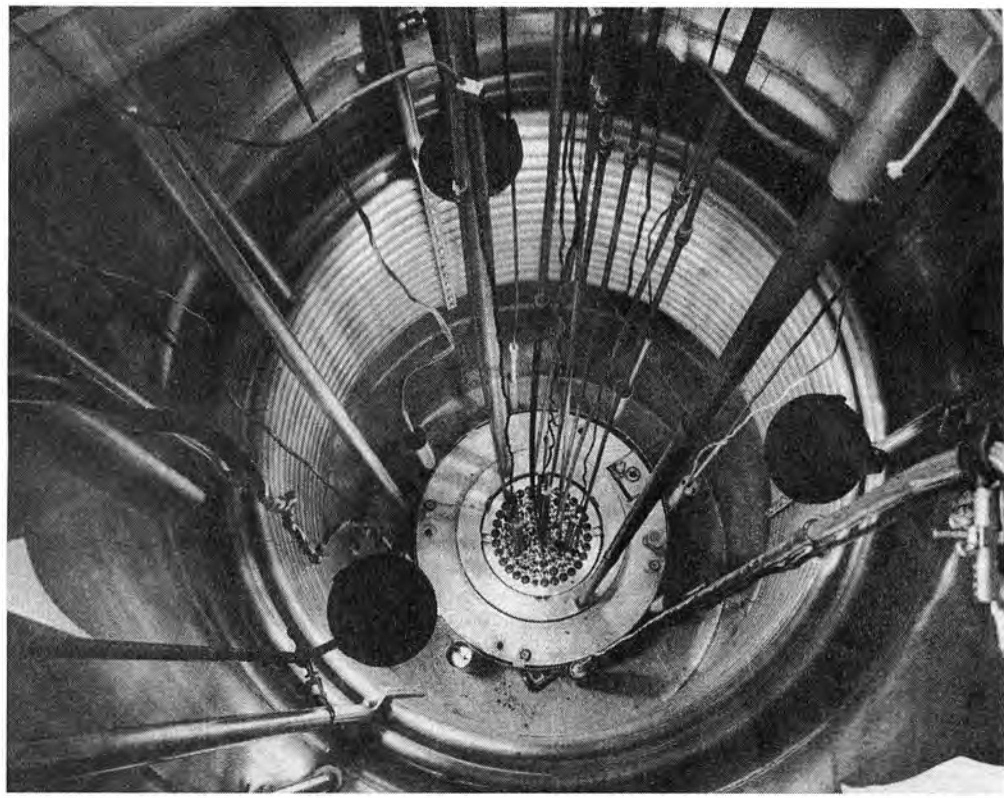

Figure 1
Looking down into the pool of the original 10 kW TRIGA Mark I reactor at GA.
Source: Illustrations are courtesy of General Atomics.

Less than five years after President Dwight D. Eisenhower's Atoms for Peace proposal to the United Nations General Assembly in December 1953, a new kind of inherently safe training, research, and isotope-production nuclear research reactor was conceived, built, and put into operation at the General Atomic Division of General Dynamics Corporation in San Diego. Known as TRIGA (which stands for Training, Research, Isotope Production, General Atomic), the nuclear reactor has evolved over the years into the most widely used research reactor in the world, with operating power levels up to 14,000 kW and designs up to 25,000 kW. Today there are 65 TRIGA reactors in 24 countries on five continents (Figure 2).[1]

In a time frame virtually unknown by today's standards, the first three TRIGA reactors were placed in operation in 1958, just *two years* after the idea for such a reactor was originally conceived. These three reactors were the prototype TRIGA reactor at General Atomic (GA) (May 3); another TRIGA which operated at the Second Geneva Conference for the Peaceful Uses of Atomic Energy (September 1-13); and a third TRIGA which started up at the University of Arizona (December 7).

Because of its simplicity and safety, the reactor was chosen by the U.S. Atomic Energy Commission (AEC) to produce short-lived radioisotopes for the U.S. government's Life Sciences Exhibit at the Geneva Conference. Delegates and other visitors to the conference were able to view the below-ground TRIGA (Figure 3) in operation, looking down through a protective water shield, and they could watch the radioisotope production process and a working neutron spectrometer continuously measuring the neutron cross sections for several typical materials.

Two more TRIGA sales were announced at the Geneva Conference. In a public ceremony at the Palais des Nations, the Italian National Committee for Nuclear Research formally signed a contract for the installation of an above-ground TRIGA at its new research center in Rome. Three days later, the Republic of Vietnam announced its selection of an above-ground TRIGA. In addition, the University of Lovanium in the Congo made arrangements to acquire the actual TRIGA that had operated in Geneva, which subsequently was shipped from Geneva to Leopoldville and became the first nuclear reactor to be installed and operated on the African continent.

The reactor demonstrations carried out at the Geneva Conference, coupled with the work of Dr. Frederic de Hoffmann, then president of GA (now General Atomics), resulted in the initiation of several additional sales of TRIGA reactors during the conference.

A year later, beginning in late 1959, another TRIGA operated at the World Agriculture Fair in New Delhi, India, as part of the U.S. Government's Life Sciences Exhibit. President Eisenhower himself pushed the button to place the TRIGA in operation as the climax to the formal opening of the exhibit (Figure 4). Accompanied by India's President Rajendra Prasad, and other notables including the renowned Indian scientist Homi J. Bhabha, President Eisenhower termed the reactor start-up "a really beautiful sight," as he and Mr. Prasad witnessed the reactor's blue glow upon attaining its steady-state operating level of 100 kilowatts. Some 3 million visitors saw that reactor in operation as it produced radioisotopes used in demonstrations of atomic energy applications in agricultural research.

With word of the new reactor spreading internationally, 20 TRIGA orders were announced from 1958 through 1961. In the United States, the University of Illinois, Cornell University, Kansas State University, the University of Texas, and the Veterans Administration Hospital in Omaha were among those making plans to install the reactor. Overseas, TRIGA research reactors were ordered for national research centers or universities in Austria, Brazil, Finland, Germany, Indonesia, Korea, Japan and Yugoslavia, and a second reactor was ordered for Italy, at the University of Pavia.

Many of these early TRIGAs were acquired with the help of grants from the U.S. Atomic Energy Commission or National Science Foundation. In many cases, the International Atomic

Figure 2
There are 65 TRIGA reactors in 24 countries on five continents. Left: A new TRIGA reactor is being built in Thailand, at the Ongkharak Nuclear Research Center near Bangkok, for the Office of Atoms for Peace.

Figure 3
Less than three years after the idea was conceived, this TRIGA reactor was in operation at the Second Geneva Conference (1958) for the Peaceful Uses of Atomic Energy.

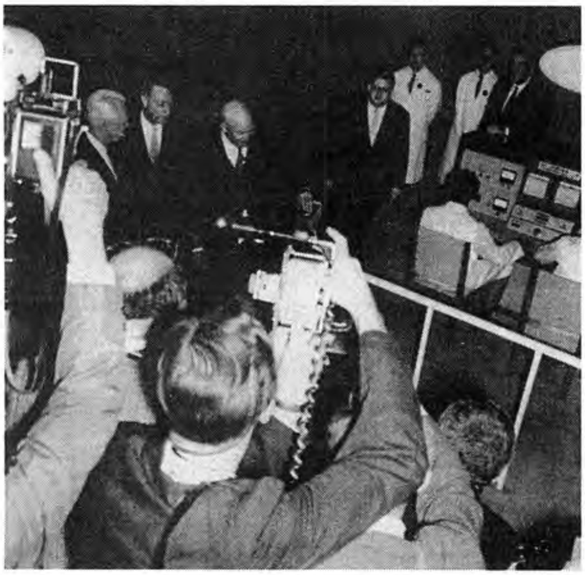

Figure 4
"A really beautiful sight": President Eisenhower (center) pushed the button to start the TRIGA in operation at the New Delhi World Agricultural Fair in 1959.

Energy Agency assisted with the supply of U.S.-origin fissile material for the reactor fuel, from the pool of special fissionable material placed at the agency's disposal by the three nuclear powers, the United Kingdom, the United States, and the Soviet Union.

Four of the TRIGAs were installed under the Atoms for Peace program itself (Korea, Vietnam, Indonesia, and Yugoslavia, which all were Third World countries at the time). The reactor for Japan's Rikkyo (St. Paul) University was purchased with the help of a fund-raising drive led by the Episcopal Church of the United States.

The Birth of TRIGA

The original TRIGA patent, "Reactor with Prompt Negative Temperature Coefficient and Fuel Element Therefor," was filed on May 9, 1958, by Theodore Taylor, Andrew McReynolds, and Freeman Dyson and assigned to General Atomic on March 31, 1964 (Figure 5).

The idea for such an inherently safe research reactor dates back to the summer of 1956, when a team of distinguished scientists was assembled in San Diego by GA (then the General Atomic Division of General Dynamics) to help the new company define its first products. The story of that summer has been described by Freeman Dyson in his 1979 book, *Disturbing the Universe*.[2] The mandate of this group, under the direction of Edward Teller, was to design a reactor so safe that if it were started from its shut-down condition and all of its control rods were instantaneously removed, it would settle down to a steady level of operation without melting any of its fuel, or releasing any fission products. (See box, page 27.)

In other words, "engineered safety," or the prevention of accidents by engineering the reactor control and safety system, was not good enough. The challenge, therefore, was to design a reactor with "inherent safety" that would be guaranteed by the laws of nature. This way, the safety of the reactor would be guaranteed even if the engineered features were bypassed, and the control rods were rapidly removed.

To meet this challenge, the idea of the "warm neutron principle" was introduced as a first step toward the design of an inherently safe reactor. Generally, in water-cooled reactors, the result of suddenly removing the control rods is a

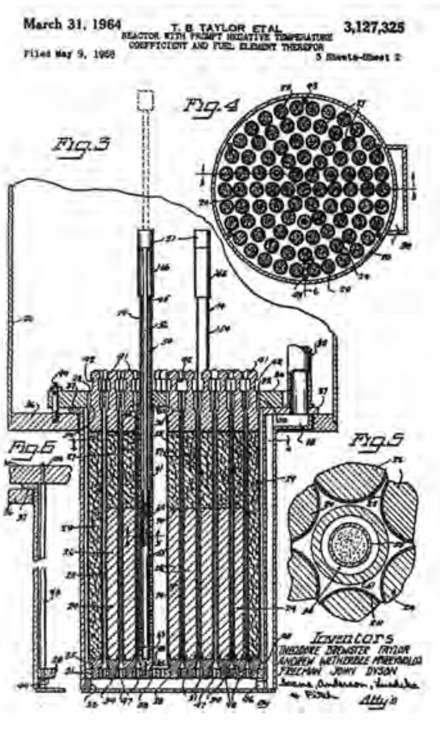

Figure 5
THE TRIGA PATENT
The TRIGA's unique design and properties are spelled out in U.S. Patent No. 3, 127, 325, filed May 9, 1958. Compare this to the cutaway view of the TRIGA in Figure 8.

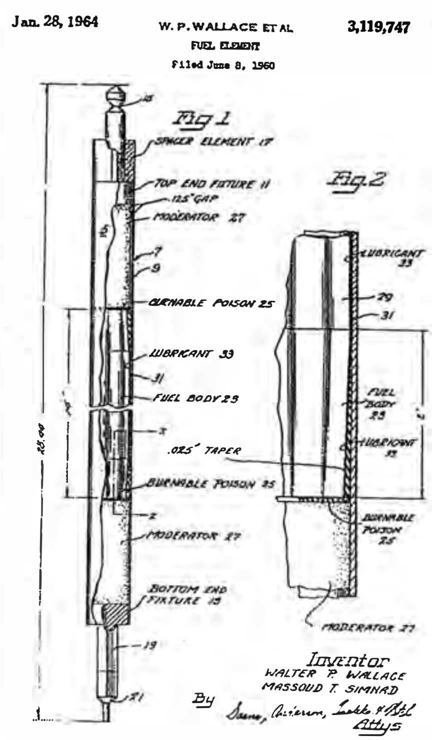

Figure 6
FUEL ELEMENT PATENT
The patent for TRIGA's fuel element, U.S. Patent No. 3, 119, 747, was filed June 8, 1960.

catastrophic accident, leading to a melting of the fuel. This is because the neutrons from the fission reaction remain "cold" from interacting with the cold water around the fuel, and thus maintain their ability to cause further fissioning of uranium atoms in the fuel. This, in turn, results in the temperature of the fuel continuing to increase rapidly, until the fuel finally melts.

TRIGA, however, is no ordinary water-cooled reactor, because much of its "moderation" of neutrons is the result of the hydrogen that is mixed in with the fuel itself. Therefore, as the fuel temperature increases when the control rods are suddenly removed, the neutrons inside the hydrogen-containing fuel rod become warmer than the neutrons outside, that are in the cold water (that is, the inside neutrons gain energy). These warmer neutrons inside the fuel cause less fissioning in the fuel, and escape from the fuel, where they are cooled in the water. Some of them then disappear by absorption into the fuel cladding material. The end result is that the reactor automatically reduces power *within a few thousandths of a second,* faster than any engineered device can operate. In other words, the fuel rods themselves act as an automatic power regulator, shutting down the reactor without engineered (mechanical) devices.

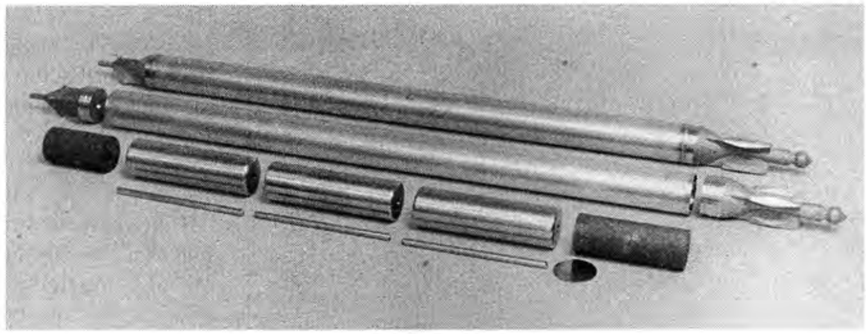

Figure 7
STANDARD TRIGA FUEL ELEMENT
TRIGA's standard UZrH fuel elements are 38-mm in diameter. Because they can hold a large amount of uranium as a small percentage of the fuel mixture, they have a longer core lifetime.

The initial patent for TRIGA fuel, "Fuel Element," was filed on June 8, 1960, by Walter Wallace and Massoud Simnad, and assigned to General Atomic on January 28, 1964 (Figure 6). By the early 1960s, GA had extended the development of hydrogen-containing uranium-zirconium (UZrH) fuel rods to have higher contents of hydrogen, increasing the hydrogen-to-zirconium atomic ratio from 1.0 to 1.7. Also, the aluminum cladding previously used was replaced with stainless steel

Teller and the TRIGA

Edward Teller in his *Memoirs,* recounts his involvement with the TRIGA.

". . .Freddie [de Hoffmann] had stayed on at Los Alamos when I left, but after a few years, he decided that he could accomplish more in industry. He went to work first for General Dynamics, and later, with the help of John Jay Hopkins, head of General Dynamics, he began his own company, General Atomic. When Freddie asked me to help, I did so. I recall the day when we drove around in Southern California and found a beautiful site a few miles north of San Diego, not far from La Jolla. Then and there, Freddie talked about the location of the circular central building that was to be surrounded by buildings housing the various projects.

"I suggested that one of his first projects should be the construction of a small foolproof reactor. I had been dreaming about and wishing for such a reactor for some time. The problem is by no means an easy one because fools are extremely ingenious in conducting their folly; this has been demonstrated over the years both in the Three Mile Island accident and at Chernobyl. The objective I had in mind was to produce a reactor that could be used in hospitals to produce short-lived radioactivities for diagnostic procedures and treatments, and in universities for research.

Stuart Lewis/EIRNS

Edward Teller in 1983.

"Freddie's immediate objection to such an installation was that reactors are dangerous unless handled by real experts. 'All right,' I said, 'let us construct a reactor that is safe even in the hands of a young graduate student.' So Freddie called together a group of people to plan a small, very safe reactor. The result was the TRIGA reactor. . . ."

Source: Edward Teller (with Judith Shoolery), *Memoirs: A Twentieth-Century Journey in Science and Politics* (Cambridge, Mass.: Perseus Publishing, 2001), p. 423.

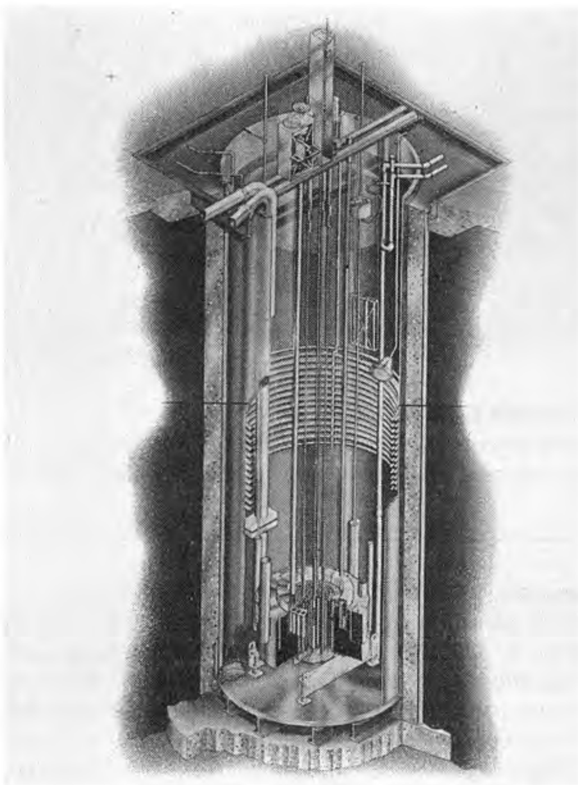

Figure 8
CUTAWAY OF THE MARK I
This cutaway view shows the internal configuration of the original 10-kW TRIGA Mark I reactor.

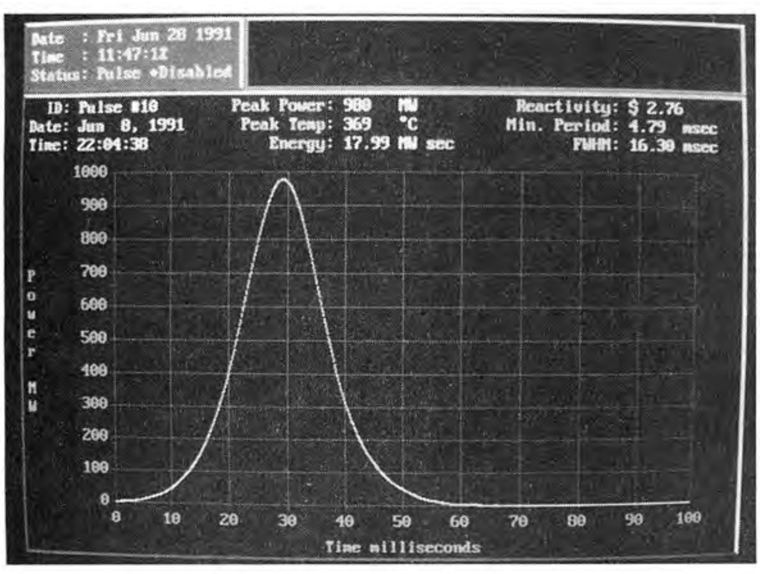

Figure 9
EXAMPLE OF TRIGA'S PULSED POWER CAPABILITY
The graph shows the time and power level of the pulsing feature of TRIGA reactors, which is used on radiation-effects testing and other research.

(Figure 7). All this further enhanced the TRIGA's safety features. The resulting metal alloy was as robust and as corrosion-resistant as stainless steel. Although safety-related incidents are rare at research reactors, the UZrH-containing fuel element made such potential incidents of no consequence at a TRIGA reactor, based on the simple physical principles of this fuel.

Temperature Coefficient

The warm neutron principle used in UZrH fuel gives the TRIGA a "prompt negative temperature coefficient of reactivity," as compared with a delayed coefficient for other types of research reactors that use aluminum-clad plate-type fuel. This allows TRIGA to withstand events that would destroy plate-fueled reactor cores. Such an unparalleled degree of safety made the reactor well suited for use in universities and research institutions, even in developing countries. It also permitted TRIGAs to be installed directly at medical institutions, such as the Veterans Administration Hospital in Omaha, and medical centers in Hannover and Heidelberg, Germany.

The UZrH fuel provides several other advantages. UZrH is chemically stable; it can be quenched at 1,200°C with no interactions in water. The high-temperature strength and ductility of the stainless steel or Alloy 800 fuel cladding provides total clad integrity at fuel temperatures as high as 1,150°C in an operating reactor (or up to 950°C with air cooling). The UZrH fuel offers far superior retention of radioactive fission products compared with aluminum-clad plate-type fuel. It can retain more than 99 percent of its volatile fission product inventory, even if all the cladding were to be removed.

The prototype TRIGA at GA was a Mark I type (Figures 1 and 8), and was originally licensed to operate at a power level of 10 kilowatts, but was soon upgraded to 250 kilowatts, with brief licensed tests conducted at power levels approaching 1,000 kilowatts. Because of its inherent safety features, this reactor could be "pulsed" to power levels of more than 1,000 megawatts, after which (and without any outside intervention) it returned in a few thousandths of a second to a safe low power, as a result of the ubiquitous warm neutrons. This pulsing feature of UZrH-fueled reactors, first demonstrated at the prototype TRIGA at GA, is now a standard feature in many TRIGA reactors (Figure 9).

A second TRIGA was built at GA in 1960, known as the Mark F, expressly to utilize these pulsing features and especially to demonstrate the behavior of UZrH fuels when pulsed to power levels even above 5,000 megawatts. This reactor was designed to provide controlled, instantaneous pulses of intense neutron and gamma radiation, for use in radiation effects testing, biomedical investigations, basic neutron physics research, and many other research studies where high neutron flux and narrow pulse widths (very short time frames) were required.

The startup of the Mark F reactor freed the original prototype Mark I reactor at GA for other types of radiation services, both for GA and outside customers. The Mark I became particularly useful in developing and demonstrating neutron activation analysis as an extremely sensitive technique for the detection of trace amounts of impurities in a variety of sample materials. GA operated a mail-order analysis service for customers sending in samples of biological materials, agricultural products, chemical and petroleum products, semiconductors, and metals. A forensic activation analysis service was also offered to law enforcement agencies.

A third TRIGA reactor was built at GA in the mid-1960s, known as the Mark III. This 2-MW reactor was installed as a below-ground facility, but served as a prototype of the later Mark III-type TRIGA reactors, which were installed above-ground. In San Diego, this reactor was designed to operate as a steady-state reactor, and served for several years as a test bed for thermionic fuel cell development.

Standard TRIGA Designs

The basic TRIGA reactor has been developed and offered to users in several standard designs. The below-ground TRIGA Mark I reactor (Figure 10) is extremely simple in physical construction. It has a graphite-reflected core installed near the bottom of an aluminum tank, and it typically operates at power levels up to 1 MW with pulsing capability. Surrounding earth and demineralized water provide most of the required radial and vertical shielding. No special containment or confinement building is necessary, and installation in an existing building has often been feasible. Core cooling is achieved through natural convection. Each Mark I reactor is equipped with various irradiation facilities, including a central thimble for high-flux irradiation, a pneumatic rabbit with in-core terminus; and a rotary specimen rack for uniform irradiations of up to 80 sample containers.

The above-ground TRIGA Mark II reactor (Figure 11) has a core that is identical to that of the Mark I but it is located in a pool surrounded by a concrete biological shield that is above the reactor room floor. The pool water provides natural convection cooling for operation up to 2 megawatts, with operation at 3 megawatts possible with forced cooling provisions. In addition to the Mark I's irradiation facilities, the Mark II includes four horizontal beam ports extending through the concrete shield to the faces of the reflector, and a graphite thermal column providing a source of well-thermalized neu-

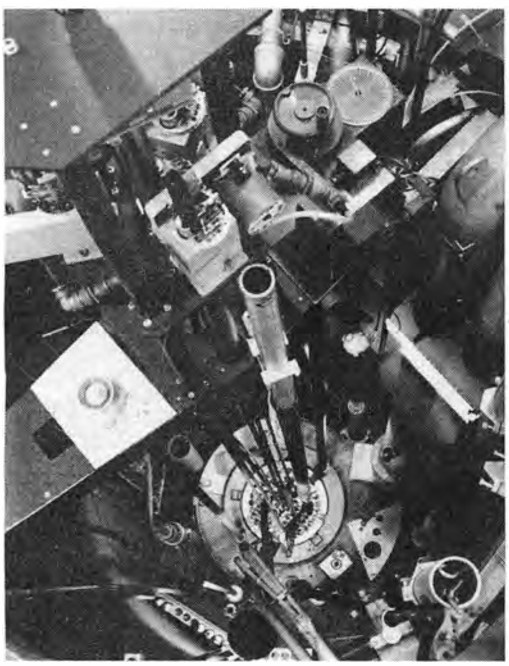

Figure 10
THE BELOW-GROUND TRIGA MARK I REACTOR
The below-ground TRIGA Mark I reactor at GA is simple in its physical construction. It has a graphite-reflected core, installed near the bottom of an aluminum tank. The surrounding earth and demineralized water provide the shielding, and no special containment building is needed.

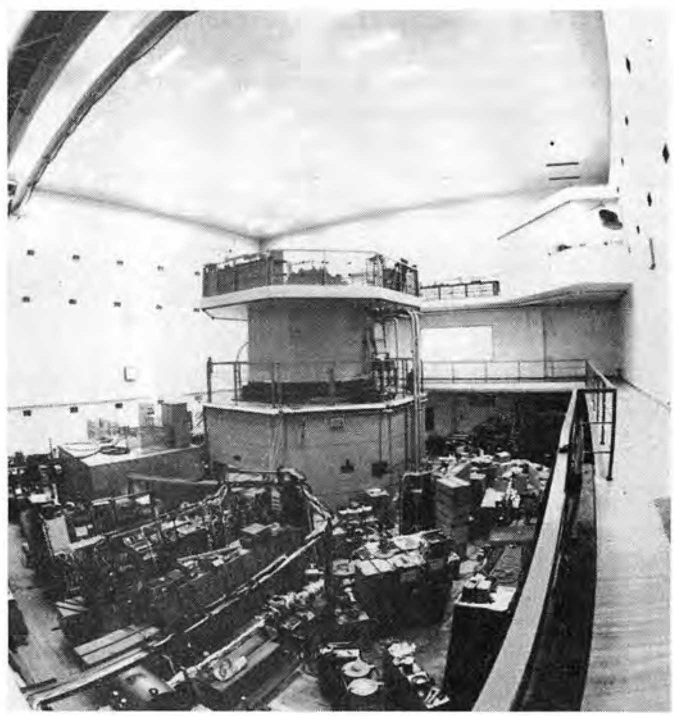

Figure 11
THE TRIGA MARK II REACTOR
The core of the Mark II is the same as that of Mark I, but it is above ground, inside a pool that is surrounded by a concrete shield that is above the reactor room floor. The Mark II has additional neutron sources for research or irradiation. This reactor is in Mainz, Germany.

trons suitable for physical research or biological irradiations. In the early TRIGA Mark II reactors, a separate thermalizing column was included, together with an associated water-filled pool for shielding studies. In recent times, users have converted these for other applications, such as dry neutron radiography facilities with built-in shielding.

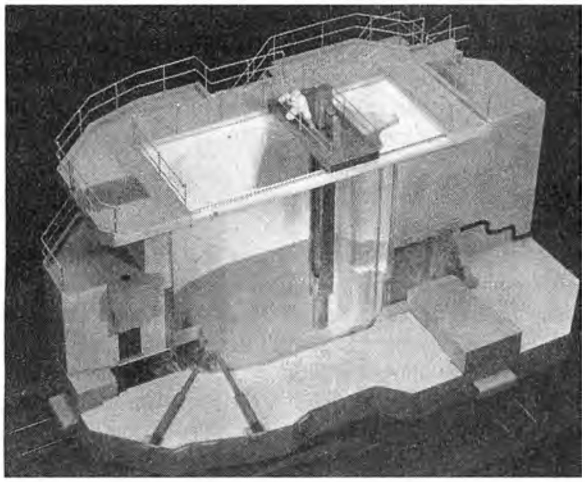

Figure 12
THE TRIGA MARK III CUTAWAY VIEW
In this later design, the reactor core is movable, so that it can operate in both a pulsed and steady-state mode. The core can move along the length of the reactor.

A later design option, TRIGA Mark III (Figure 12), provided a movable reactor core, supporting both steady-state, up to 2 MW, and pulsing operations, but with greatly increased operational flexibility. The core can be moved to one end of the pool for experiments in an adjacent dry, walk-in exposure room, or to the opposite end for experiments involving the thermal columns and beam ports, or used in the center of the pool for isotope production and other applications.

Instrumentation and control (I&C) systems for all new TRIGA reactors have now evolved into compact, microprocessor-driven systems. As with previous generations of the I&C systems, they are designed to enable inexperienced students and nontechnical personnel to operate the reactor with a minimum of training, and with the simplicity of the inherently safe characteristics derived from the physical properties of the UZrH fuel. Four operating modes are typically available: manual, automatic, pulsing, and "square wave," the last being a one-button startup sequence for bringing the reactor up quickly (a few seconds) to its operating steady-state power level. TRIGA reactors have also been licensed to operate in an unattended mode, again as a result of the protection afforded by the safety characteristics of the UZrH fuel.

TRIGA Reactors Evolve

During the 1960s, 1970s, and 1980s, a number of low- and medium-power, as well as higher-power, TRIGA installations were built and operated, often making use of the reactor's pulsing capability. A TRIGA reactor with a movable core arrangement at the Armed Forces Radiobiology Research Institute at Bethesda, Md., was built for research on the bio-

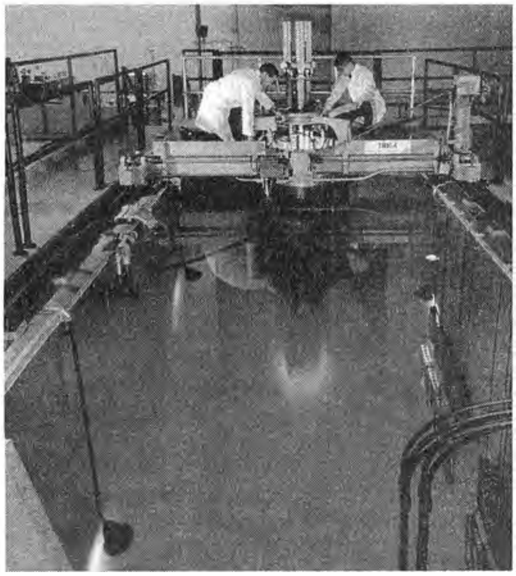

Figure 13
MOVABLE CORE TRIGA REACTOR
This reactor was located at the Northrop Corp., in California.

Figure 14
THE TRIGA MARK III AT THE UNIVERSITY OF CALIFORNIA
This now-decommissioned TRIGA Mark III reactor is at University of California, Berkeley campus. A similar reactor is in operation at the Institute of Nuclear Research in Mexico City.

logical effects of radiation, including studying biomedical effects of intense nuclear radiation to which military and civilian populations might be exposed in the event of nuclear attack. The Army's Harry Diamond Laboratories in Maryland have operated a movable core reactor for radiation-effects testing of electronic components, as has Northrop Corporation in California (Figure 13). TRIGA Mark III reactors were built at the University of California's Berkeley campus, now decommissioned (Figure 14), and at the Institute of Nuclear Research in Mexico City.

An early TRIGA Mark II, at Musashi Institute of Technology in Japan, was adapted for pioneering research and therapeutic treatment for malignant, inoperable brain tumors and melanoma, using the Neutron Capture Therapy (NCT) technique. About 125 brain tumor patients have been treated at the Musashi facility.

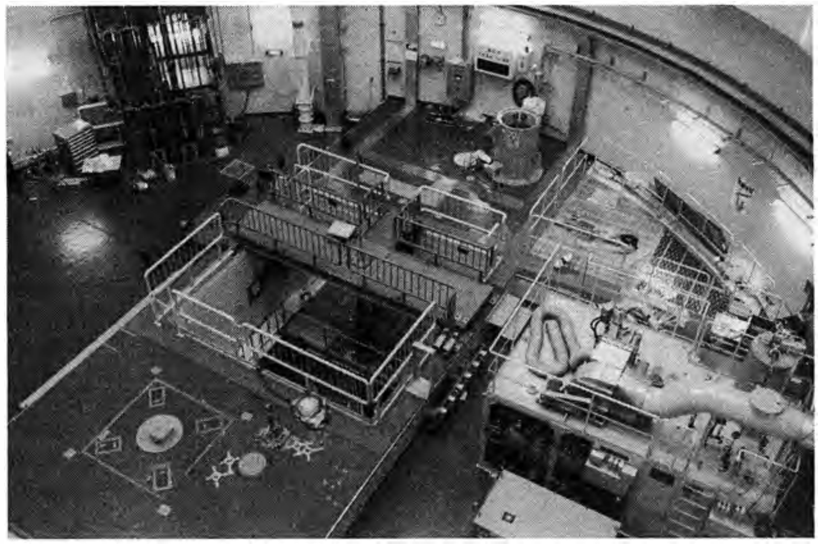

Figure 15
JAPAN'S TRIGA AT TOKAIMURA
This TRIGA is an annular core pulsing reactor, at the Japan Atomic Energy Resarch Institute.

Annular Core Pulsed TRIGA Reactors were designed and built for use at Sandia National Laboratory, the Institute for Nuclear Technologies in Romania, and the Japan Atomic Energy Research Institute (Figure 15). These have routinely achieved pulsed power levels up to 22,000 megawatts for testing power reactor fuels. These reactors have a large (25-cm diameter), dry central test cavity (Figure 16) that can accommodate samples in the central core regions. They employ specially designed cladding for the UZrH fuel elements, permitting higher peak fuel temperatures in standard UZrH material, while retaining the inherent safety and simplicity of natural convection cooling.

A special-purpose TRIGA was designed and commissioned for the U.S. Air Force at McClellan Air Force Base, in California, for real-time neutron radiography inspection of large aircraft components. Known as the Stationary Neutron Radiography System (SNRS), this is a modified Mark II reactor that has provided high-volume, real-time inspection of large parts, such as complete aircraft wings and subassemblies. A custom-designed TRIGA reactor with four neutron beam ports transmits neutrons to special component inspection bays, where parts are robotically positioned and imaged in real time using digital imaging techniques, as well as the traditional film technique. The reactor was transferred in place to the University of California-Davis (the Air Force base itself was closed in 2001). The reactor facility, now known as the McClellan Nuclear Radiation Center, offers services in nondestructive inspection, irradiation, radioisotope production, and other areas.

The use of TRIGA fuels was extended in the 1980s in cooperation with the Department of Energy's Reduced Enrichment for Research and Test Reactors program, by designing and qualifying proliferation-resistant (low-enriched uranium) UZrH fuels. These fuels were developed with higher uranium

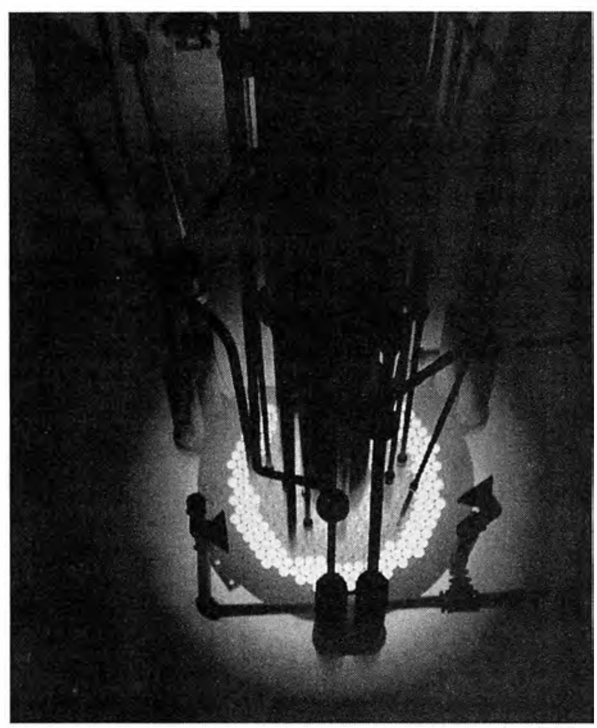

Figure 16
ANNULAR CORE PULSED TRIGA REACTOR
The annular core of this TRIGA has a dry central cavity that can hold research samples. Its fuel has special cladding to allow it to reach higher peak temperatures.

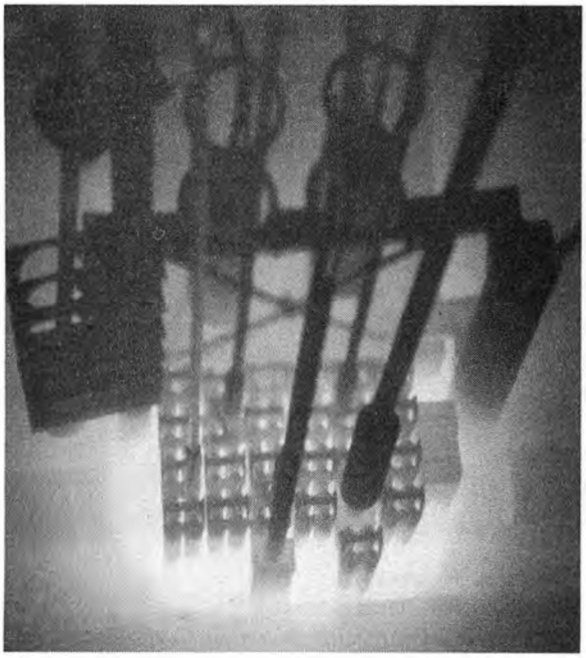

Figure 17
TRIGA CONVERSION REACTOR
TRIGA-type fuel has been installed in several research reactors that were built with plate-type fuel. Here, the converted reactor at the University of Maryland.

densities for use in the higher power regimes where newer TRIGAs were being designed to operate. This fuel design continues to provide the highest degree of safety against nuclear incidents, regardless of power level.

One other major development, which started as early as the late 1960s, was the conversion of existing non-TRIGA research reactors that used plate-type fuel to TRIGA-type fuel. In most cases, the converted reactors have retained their existing core grid structure, and, in some cases, their existing reactor control systems. The conversion to a complete TRIGA-type reactor is accomplished using TRIGA four-rod clusters, and can be added a few clusters at a time to an operating plate-type core. The resulting conversion provides a dual steady-state/pulsing capability in a range of designs rated from less than 1 MW to 3 MW.

Research reactors with plate-type fuel that have converted to TRIGAs include installations at the Universities of Maryland (Figure 17), Penn State, Texas A&M, Washington State, and Wisconsin, as well as locations *in* Taiwan, Thailand, the Philippines, and (most recently) Colombia.

General Atomics also began incorporating modifications to accommodate higher-power TRIGA operations (5 to 25 MW). A smaller diameter (13-mm) UZrH fuel rod with a high strength and ductility Inconel alloy cladding (Figure 18), and forced cooling to replace natural convection cooling, were included in the 14-MW TRIGA reactor commissioned in Romania in 1980 (Figure 19). Designs using the smaller diameter fuel rods have been extended to steady-state power levels up to 25 MW.

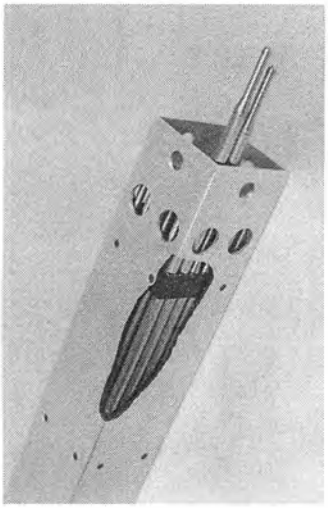

Figure 18
HIGH POWER FUEL ELEMENT
Smaller diameter (13-mm) fuel rods have been adapted so that they can accommodate higher power TRIGA operations (5 to 25 MW).

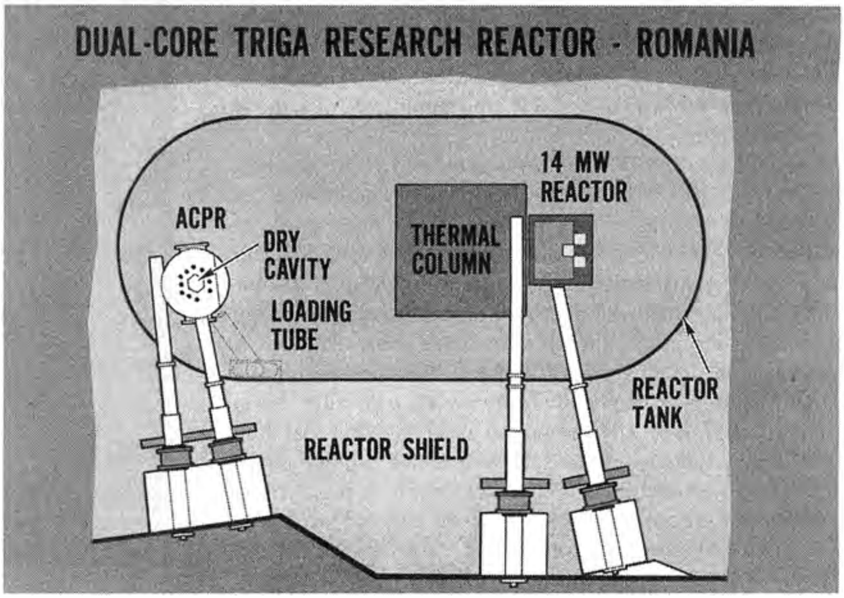

Figure 19
DIAGRAM OF THE 14-MW TRIGA REACTOR IN ROMANIA
This reactor, commissioned in 1980, has two reactors in the same reactor pool. One (at left) uses annular core pulsing and can reach peaks of 20,000-MW, while the other is a 14-MW steady-state reactor.

The Newest TRIGAs: Thailand and Morocco

Today, two new TRIGA construction projects are under way. The first involves a 10-MW multipurpose TRIGA reactor that will be at the center of a Nuclear Research Center being built for Thailand's Office of Atoms for Peace near Bangkok. (See Figure 2.) It will use the same high-density small-diameter fuel type that has been successfully demonstrated to very high burnups in the Romanian TRIGA reactor, and will include a radiation treatment facility for neutron cancer therapy; production of medical and industrial radioisotopes, and high-purity semiconductor materials for the electronics industry; and neutron-beam research facilities to meet Thailand's science and education needs.

The second project involves a 2-MW TRIGA Mark II research reactor, with provisions to be upgraded to 3 MW, under construction at the Kingdom of Morocco's National Center for Nuclear Science, Energy and Technology (CNESTEN) near Rabat (Figure 20). The center, whose remaining infrastructure has recently been completed, will provide broad capabilities for performing basic research and training in such areas as isotope production, metallurgy, and chemistry. The TRIGA reactor and associated laboratories form the centerpiece of this new facility, which is expected to evolve into a regional center of excellence.

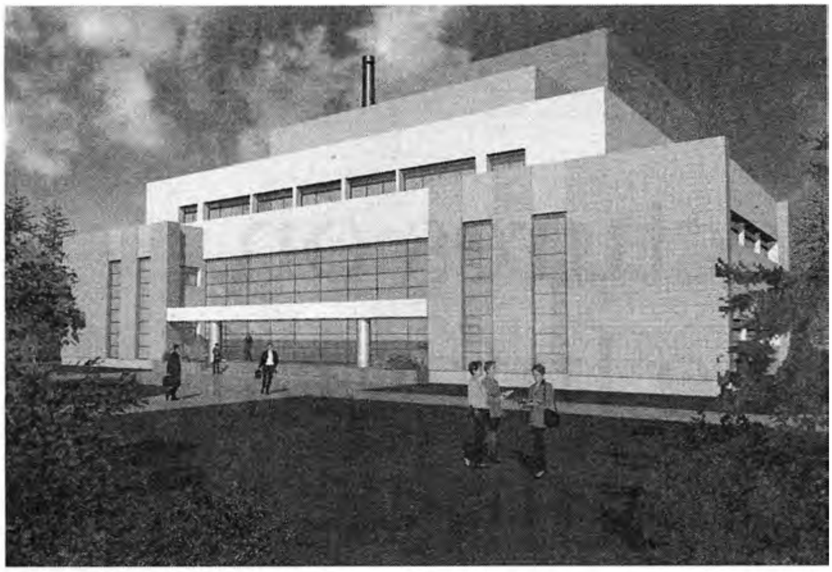

Figure 20
TRIGA MARK II REACTOR TO BE BUILT IN MOROCCO
This artist's illustration shows the reactor hall and laboratories at the Nuclear Energy Center being constructed by the National Center for Nuclear Science, Energy, and Technology of Morocco, located north of the city of Rabat. The TRIGA Mark II will be the centerpiece of the facility. This is a turnkey project, financed through the U.S. Export-Import Bank.

Throughout their 45 years of operating history, TRIGA reactors have demonstrated several common features that have made them so widely used in supporting the peaceful applications of atomic energy. Their simple design, ease of operation, versatility, and safety have made them unique—whether for basic student-type training and isotope production, or for advanced scientific research involving sophisticated beam experiments, and also for medical uses such as Neutron Capture Therapy.

More Applications

In the steady-state mode of operation, TRIGA reactors provide much the same research and training capabilities as other types of research reactors. These include neutron activation analysis, radioisotope production, neutron transmutation doping of silicon, and a variety of neutron-beam applications, including neutron radiography and Neutron Capture Therapy. In addition, however, TRIGA reactors offer the unique and added capabilities to produce pulsed bursts of neutrons. This capability has provided scientists and researchers a wide variety of additional areas of research applications. These have included: studies of biomedical effects in pulsed radiation fields, transient radiation effects in electronic components, tests of power reactor fuel under simulated accident conditions, and the production of very-short-lived radionuclides for radiochemistry and nuclear physics studies, using 500- to 2,000-MW pulses. More recently, the precision in reactor control made possible by the use of digital electronics has allowed pulsing TRIGA reactor designs to offer "continuous pulsing" at power levels reaching 50 MW. The latter would serve in lieu of a pulsed spallation accelerator system as a neutron source for neutron beam applications.

And what about that original prototype TRIGA reactor at General Atomics in San Diego? In 1997, it was shut down permanently because of its age, but not before it had been designated by the American Nuclear Society in 1986 as a Nuclear Historic Landmark. The citation highlighted its role in pioneering the use of unique, inherently safe capabilities in nuclear reactors.

Douglas M. Fouquet is Coordinator, Public Relations; Junaid Razvi is Senior Program Manager, TRIGA Reactors; and William L. Whittemore is Senior Scientific Advisor, TRIGA—all at General Atomics in San Diego, Calif. TRIGA is a registered trademark™ of General Atomics.

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Notes

1. A complete list of TRIGA reactors around the world can be found at http://triga.ga.com.
2. Freeman Dyson, "Little Red Schoolhouse" in *Disturbing the Universe* (New York: Basic Books, 1979).

Lectures on The Integral Calculus

Johann Bernoulli

(Translated by William A. Ferguson, Jr.)

The first English translation of selections from Bernoulli's groundbreaking work identifying the curve formed by a hanging chain suspended at both ends.

Johann Bernoulli (1667-1748)

EDITOR'S NOTE

In 1690, Jakob Bernoulli, brother of Johann, published a challenge to the scientific world in the *Acta Eruditorum* of Leipzig, to determine the geometry of the catenary. Johann Bernoulli, Gottfried Leibniz, and Christiaan Huygens each independently solved the problem. All three solutions were published in the *Acta* in 1691.

Johann Bernoulli then treated the subject in his *Lectures on the Integral Calculus,* which were written out for the use of the mathematician Guillaume Marquis de L'Hôpital in 1691-1692, while Bernoulli was residing in Paris. The excerpts presented here are from this work.

Part I is on the physics of the hanging chain. Part II provides the derivation of the differential equation of the curve whose geometry corresponds to the physics of the hanging chain. Part III is the proof that Leibniz's solution, based on the logarithmic curve, is identical. These three parts are Lecture Thirty-Six, part of Lecture Twelve, and Lecture Thirty-Seven, respectively.

The text is from *Die erste Integralrechnung, Eine Auswahl aus Johann Bernoullis mathematischen Vorlesungen über die Methode der Integrale* (Leipzig and Berlin: Wilhelm Engelmann, 1914), itself a translation into German by Gerhard Kowalewski of a selection of lectures from the Latin original, *Lectiones mathematicae de methodo integralium.* The figures are reproduced from the Kowalewski translation. The reader should not assume that the figures are exact constructions. The Kowalewski translation may be found at http://historical.library.cornell.edu/cgibin/cul.math/docviewer?did=Bern002&seq=5

All material in square brackets has been supplied by the translator. The footnotes are by the German (Kowalewski) or the English translator (Ferguson), as noted in square brackets at the end of each note.

The translator thanks the staff of the Burndy Library, of the Dibner Institute for the History of Science and Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts, for making available a copy of the Latin original, *Lectiones mathematicae de methodo integralium,* as an aid to translation.

I. Lecture Thirty-Six
On Catenaries

The importance of the problem of the catenary in Geometry can be seen from the three solutions in the *Acta* of Leipzig of last year (1691), and especially from the remarks that the renowned Leibniz[1] makes there. The first to consider this curve, which is formed by a free-hanging string, or better, by a thin inelastic chain, was Galileo. He, however, did not fathom its nature; on the contrary, he asserted that it is a parabola, which it certainly is not. Joachim Jungius discovered that it is not a parabola, as Leibniz remarked, through calculation and his many experiments. However, he did not indicate the correct curve for the catenary. The solution to this important problem therefore remained for our time. We present it here together with the calculation, which was not appended to the solution in the *Acta*.

There are actually two kinds of catenaries: the common, which is formed by a string or a chain of uniform thickness, or is of uniform weight at all points, and the uncommon, which is formed by a string of non-uniform thickness, which therefore is not of uniform weight at all points, and certainly not uniform in relation to the ordinates of any given curve.

Before we set about the solution, we make the following assumptions, which can easily be proven from Statics.

1. The string, rope, or chain, or whatever the curve consists of, will be assumed to be flexible and inelastic at all of its points, that is, it undergoes no stretching as a result of its weight.

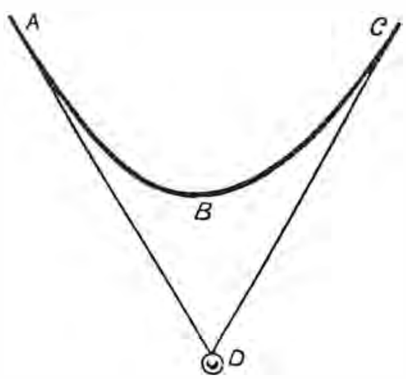


Figure 1

2. If the catenary *ABC* [Figure 1] is held fixed at any two points *A* and *C*, then the necessary forces at points *A* and *C*, are the same as those which support a weight *D*, that is equal to the weight of the chain *ABC* and is located at the meeting point of two weightless strings *AD* and *CD*, that are tangent to the curve at points *A* and *C*. The reason for this is clear: Because the weight of the chain *ABC* exerts its action at *A* and *C* in one direction [at each point], namely, in the directions of the tangents *AD* and *CD*, and the pull of the same or equal weight *D* at *A* and *C* likewise goes in the directions of *AD* and *CD*. Therefore the necessary forces at points *A* and *C* must also in both cases be the same. Accordingly, one obtains the necessary force at the lowest point *B*, when one seeks the force that the weight *E* [Figure 2] exerts at the same point, when it is held by two weightless strings, one of which is tangent to the curve at *B*, and therefore is horizontal, while the other is tangent to the curve at point *A*.

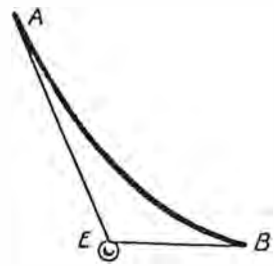


Figure 2

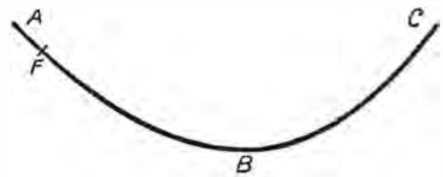


Figure 3

3. When a chain fastened at points *A* and *C* is then fastened at any other point *F* [Figure 3], so that one could remove the portion *AF*, the curve represented by the remaining piece of chain *FBC* does not change, that is, the remaining points will stay in the same position as before the fastening [at *F*].

This needs no proof, because Reason advises it and experience lays it daily before our eyes.

4. If we retain the previous assumptions, then before and after the fastening [at *F*], the same (that is, the original) force must obtain at particular positions on the curve, or, what amounts to the same thing, a point will be pulled with the same force after the fastening [at *F*] as before it. This is nothing but a corollary of the preceding number. Consequently, as one lengthens or shortens the chain *BFA*, that is, wherever one chooses the fastening point *F*, the force at the lowest position *B* neither increases nor decreases, but always remains the same.

5. The weight *P* [Figure 4], which is held by any two arbitrarily situated strings *AB* and *CB*, exerts its forces on the points *A* and *C* in such a relation, that the necessary force at *A* is to the necessary force at *C* (after drawing vertical line *BG*), as the sine of angle *CBG* is to the sine of angle *ABG*, and the force of the weight *P* is to the force at *C* as the sine of the whole angle *ABC* is to the sine of the opposite angle *ABG*. This is proven in every theory of Statics.[2]

With these assumptions, we find the common catenary curve in the following manner. Let *BAa* be the desired curve [Figure 5]; *B*, its deepest point; the axis or the vertical through *B*, *BG;* the tangent at the deepest point, which will be horizontal, *BE;* and let *AE* be the tangent at any other point *A*.

Draw the ordinate AG and the parallel EL to the axis. Let

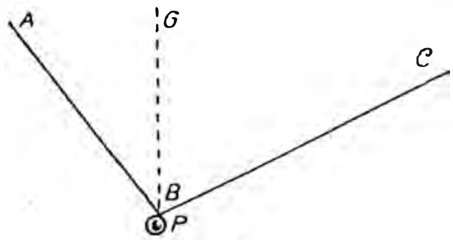


Figure 4

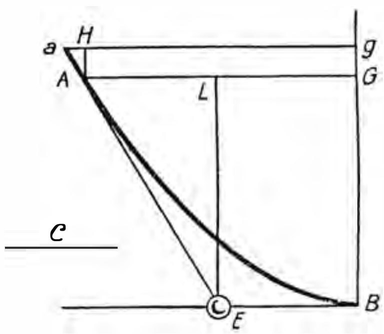


Figure 5

$$BG = x,\quad GA = y,\quad Gg = dx,\quad Ha = dy,$$

and the weight of the chain, or, since it is of uniform thickness, the length of the curve $BA = s$. Since at point B, an ever constant force will be required (by assumption 4), whether the chain be lengthened or shortened, that force, or the segment $C = a$ expressing it, will therefore be a constant.[3] Imagine now that the weight of the chain AB is concentrated at and hangs at the meeting point E of the tangent strings AE, BE; then (by assumption 2) the same force is required at point B to hold the weight E as was required to hold the chain BA. But the weight E (by assumption 5) is to the force at B, as the sine of the angle AEB, or as the sine of its complementary angle EAL is to the sine of angle AEL, that is, as EL is to AL. Wherever on the curve one chooses the fixed point A (the curve always remains the same, by assumption 3), the weight of the chain AB is to the force at B [which force equals the constant a], as EL is to AL, that is,

$$s : a = EL : AL = AH : Ha = dx : dy$$

and if one inverts,

$$dy : dx = a : s.$$ [4]

Hence it follows that the catenary BA is the same as that curve whose construction and nature we have given above, by the method of inverse tangents [provided here as Part II, below], where we first converted the proportion $dy : dx = a : s$ to the following:

$$dy = \frac{adx}{\sqrt{2ax + x^2}},$$

at which point the curve was constructed through the rectification of the parabola as well as through the quadrature of the hyperbola.

II. Part of Lecture Twelve on Inverse Tangents

IV. To find the nature of the curve so created that $DC : BC = E : AD$ [Figure 6].

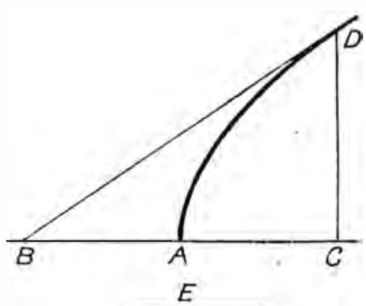


Figure 6

Let $AC = x$, $CD = y$, $AD = s$ [and the given constant segment $E = a$]. By assumption,

$$\frac{dy}{dx} = \frac{a}{s}, \text{ therefore } dy = \frac{adx}{s}.$$

However, to be able to eliminate the letter s (which is always necessary in the determination of curves), one must proceed thus:

$$dy^2 = \frac{a^2dx^2}{s^2},$$

therefore,

$$ds^2 = dx^2 + dy^2 = \frac{s^2dx^2 + a^2dx^2}{s^2}$$

and

$$ds = \frac{dx\sqrt{s^2 + a^2}}{s},$$

therefore

$$dx = \frac{sds}{\sqrt{s^2 + a^2}}$$

and the integral thereof,

$$x = \sqrt{s^2 + a^2}.$$

From this is obtained

$$s = \sqrt{x^2 - a^2}$$

and

$$ds = \frac{xdx}{\sqrt{x^2 - a^2}} = \sqrt{dx^2 + dy^2}.$$

If the equation is simplified, one obtains

$$x^2dy^2 - a^2dy^2 = a^2dx^2$$

and finally

$$dy = \frac{adx}{\sqrt{x^2 - a^2}}.$$

The same result is achieved otherwise and more easily in the following manner.

Because $s = adx/dy$, then[5]

$$ds = \sqrt{dx^2 + dy^2} = \frac{ad^2x}{dy}$$

and hence

$$dy = \frac{ad^2x}{\sqrt{dx^2 + dy^2}}.$$

To be able to take the integral on both sides, both sides are multiplied by dx. Then one obtains

$$dx\,dy = \frac{adx\,d^2x}{\sqrt{dx^2 + dy^2}}.$$

If the integral be taken, the result is

$$xdy = a\sqrt{dx^2 + dy^2},$$

and after simplifying the equation,

$$dy = \frac{adx}{\sqrt{x^2 - a^2}},$$

as before.

Now we come to the construction of this curve. It should be noted, first of all, that because $x = \sqrt{s^2 + a^2}$ and hence $x > s$, the invariant origin of x lies beyond the vertex B, and indeed at the distance E, since if $s = o$, then $x = a$ necessarily. Hence if we wish to place the origin of x at the vertex itself, we must set $x = x + a$. Then the equation $dy = adx/\sqrt{x^2 - a^2}$ is transformed into the following:

$$dy = \frac{adx}{\sqrt{2ax + x^2}},$$

which we will now construct in a three-fold way.

Multiply the equation by a. Then

$$ady = \frac{a^2dx}{\sqrt{2ax + x^3}},$$

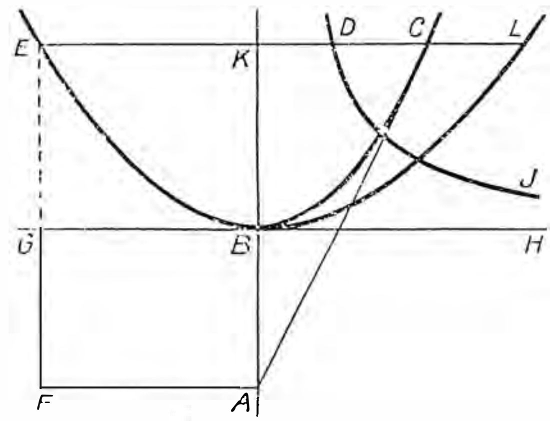


Figure 7

Now draw the normals AK, GH, which will intersect at B [Figure 7]; take $BA = a$ and draw with vertex B and midpoint A the equilateral hyperbola BC. Construct further a curve DJ, such that BA is everywhere the mean proportional between KC and KD, that is, that

$$KD = \frac{a^2}{\sqrt{2ax + x^2}}.$$

Next, draw the parallel AF and make the area of the rectangle AG equal to that of $HBKDJ$. If we now extend DK and FG, their intersection E will lie on the desired curve.[6]

The curve admits of another and easier construction in the following manner. Draw the line AC and make the area of rectangle AG equal to double the hyperbolic area ABC. Then after the extension of CK and FG, the point E again will lie on the same desired curve.[7, 8]

It may be constructed in yet another way, by means of the rectification of a parabolic curve, in the following manner. Because $dy = adx/\sqrt{2ax + x^2}$, therefore

$$dy + \frac{adx + xdx}{\sqrt{2ax + x^2}} \text{ (differential of } EK + KC = EC)$$

$$= \frac{2adx + xdx}{\sqrt{2ax + x^2}} = \frac{dx\sqrt{2a + x}}{\sqrt{x}}.$$

Hence one must find a certain curve BL, whose differential is $dx\sqrt{2a + x}/\sqrt{x}$. Then BL itself will be equal to EC. But one finds this curve thus: From

$$\frac{2adx^2 + xdx^2}{x},$$

subtract dx^2. Then $2adx^2/x$ remains. Hence

$$\frac{dx\sqrt{2a}}{\sqrt{x}} = \text{ differential of } KL,$$

and

$$\int \frac{dx\sqrt{2a}}{\sqrt{x}}, \text{ that is, } \sqrt{8ax},$$

will therefore be equal to KL itself. The curve BL is consequently a parabola of parameter $8AB$. If this BL be laid out as a straight line and abutted to point C as ordinate, the other endpoint E again will lie on the desired curve BE.[9,10]

Corollary. The length of the curve BE is equal to the hyperbolic ordinate KC. If the length of BE is designated by s, then

$$ds = \sqrt{dx^2 + dy^2} = \sqrt{dx^2 + \frac{a^2dx^2}{2ax + x^2}} = dx\sqrt{\frac{a^2 + 2ax + x^2}{2ax + x^2}}$$

$$= \frac{adx + xdx}{\sqrt{2ax + x^2}} = \text{ differential of } KC.$$

III. Lecture Thirty-Seven
Continuation of the Same Subject: On Catenaries

So that the correctness of our solution be made even clearer, we will test whether it agrees with the solution of Mr. Leibniz. His construction of the catenary is of the following nature.

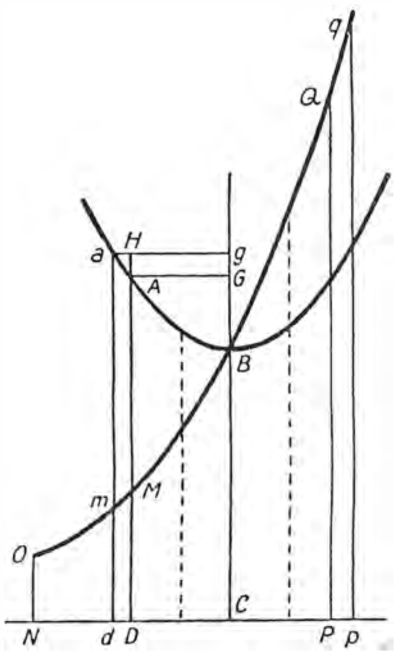


Figure 8

Let NCP be an unbounded horizontal straight line [Figure 8], and above it let the logarithmic curve $OMBQ$ be drawn,[11] whose subtangent therefore is everywhere the same. Choose the ordinate CB, which is equal to the subtangent, and take on both sides of it arbitrary and equal segments CD, CP. Now make DA equal to the semi-sum of the ordinates DM, PQ. Then, he asserts that the point A lies on a catenary.[12]

In order to test, whether this curve is the same as the one we have indicated, we must see whether the nature of the curve BA is expressed by the same differential equation. Let then CB or the subtangent $= a$, $BG = x$, $GA = CD = y$, $DM = z$, $Gg = dx$, $Dd = Ha = dy$. Then, by the nature of the logarithmic curve, $zdy = adz$, thus

$$dz = \frac{zdy}{a}.$$

Since by construction, $CD = CP$, then $DM : CB = CB : PQ$, therefore $PQ = a^2/z$ and $\frac{1}{2}DM + \frac{1}{2}PQ$, that is, DA by construction,

$$= \frac{a^2 + z^2}{2z} = CB + BG = a + x,$$

therefore

$$z^2 = 2az + 2xz - a^2.$$

When solved, this equation yields,

$$z = a + x + \sqrt{2ax + x^2},$$

therefore

$$dz = dx + \frac{(a + x)dx}{\sqrt{2ax + x^2}}.$$

If one substitutes this value of z in the earlier equation $dz = zdy/a$, the result is

$$dx + \frac{(a + x)dx}{\sqrt{2ax + x^2}} = \frac{ady + xdy + dy \cdot \sqrt{2ax + x^2}}{a}$$

or

$$\frac{adx \cdot \sqrt{2ax + x^2} + a^2dx + ax\,dx}{\sqrt{2ax + x^2}}$$

$$= ady + xdy + dy \cdot \sqrt{2ax + x^2}.$$

Dividing both sides by $a + x + \sqrt{2ax + x^2}$, one obtains

$$\frac{adx}{\sqrt{2ax + x^2}} = dy.$$

Because this equation is the same as the one that we have found, it follows that the curve BA is also our catenary, and that the Leibnizian construction, as different as it may be from the one we have given above, indeed produces no other line.

It remains to add the most important properties of the simple catenary, and that with calculation and proof, which was not done in the *Acta*. We will use the figure that appears in the *Acta* [Figure 9]. There, EBF is the catenary, B its deepest point, BA the axis, BG the equilateral hyperbola that can be termed generative, and BH the parabola, through whose rectification the catenary line EBF is constructed.

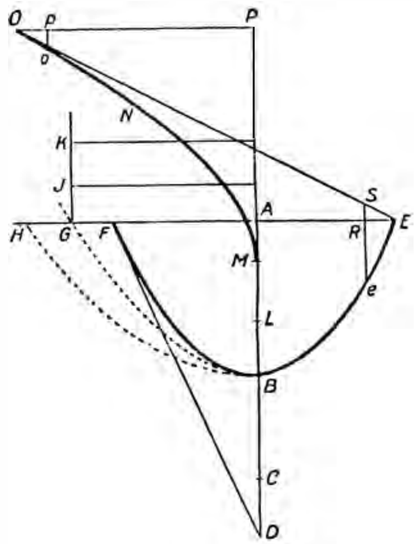


Figure 9

1. Draw the tangent FD; then $AF : AD = BC : (BF$, the curve), because

$AF : AD = dy : dx$.

However we found by calculation that

$dy : dx = a : s$.

Therefore, the statement is correct.

2. AE or AF is equal to the parabolic curve BH, minus the segment AG. This is clear, because by construction, EG was taken equal to BH.

3. The length of the curve BE or BF is equal to the segment AG; that is, the portions of the catenary, if one lays them out upon the axis as ordinates, form an equilateral hyperbola.[13] That is a remarkable property of this curve. We have proven this by the method of inverse tangents (see page 31).

4. The area of the catenary region BAE or BAF is equal to the rectangle of BA and AF, minus the rectangle of CB and FG. Since of course

$$dy = \frac{adx}{\sqrt{2ax+x^2}}$$

therefore

$$xdy = \frac{axdx}{\sqrt{2ax+x^2}} = \frac{(ax+a^2)dx}{\sqrt{2ax+x^2}} - \frac{a^2dx}{\sqrt{2ax+x^2}}$$
$$= \frac{(ax+a^2)dx}{\sqrt{2ax+x^2}} - ady.$$

Therefore the integral of xdy, that is, the complement of the area BAF, is equal to the integral of the latter, and therefore equal to

$$a\sqrt{2ax+x^2} - ay = CB \cdot AG - CB \cdot AF = CB \cdot FG,$$

and consequently the area BAF itself $= BA \cdot AF - CB \cdot FG$.

5. The length of the curve MNO, the involute of which forms the catenary BE, is the third proportional of CB and AG. To discover that this is so, one would first find the length of the unwinding tangent line EO; above, in the article on the development of curves [in Lecture Sixteen, not translated here], we have shown that in general, for all curves, it is equal to

$$\frac{(dx^2+dy^2)\sqrt{dx^2+dy^2}}{-d^2y\,dx}.$$

For the curve in question then,

$$dx^2+dy^2 = ds^2 = \frac{(a^2+2ax+x^2)\,dx^2}{2ax+x^2},$$

and, since

$$dy = \frac{adx}{\sqrt{2ax+x^2}},$$

hence

$$d^2y = -\frac{(a^2+ax)dx^2}{(2ax+x^2)\sqrt{2ax+x^2}}.$$

From this is obtained, for the whole expression,

$$\frac{(dx^2+dy^2)\sqrt{dx^2+dy^2}}{-d^2y\,dx} = EO = \frac{a^2+2ax+x^2}{a}.$$

From this, subtract that which the assumption $x = o$ yields; then what remains is

$$\frac{2ax+x^2}{a} = \text{ the length of curve } MNO.$$

Therefore a or CB is to $\sqrt{2ax+x^2}$ or AG, as AG is to MNO.

6. The unwinding tangent EO is the third proportional of CB and CA. For, since

$$EO = \frac{a^2+2ax+x^2}{a},$$

a or CB is to $a + x$ or CA as CA is to EO.

7. The line BM, which extends to the beginning of the curve MNO, is equal to CB. Since of course $x = o$, the unwinding tangent EO, which is now BM, becomes equal to $a = CB$.

8. MP is twice BA. Because

$$MNO = \frac{2ax+x^2}{a},$$

the differential will be

$$Oo = \frac{(2a+2x)dx}{a}.$$

But the triangle Oop is similar to triangle ESR and hence also to triangle eER; consequently $Ee : ER = Oo : po$, that is,

$$\frac{adx+xdx}{\sqrt{2ax+x^2}} : \frac{adx}{\sqrt{2ax+x^2}} = \frac{2adx+2xdx}{a} : po,$$

therefore $2dx = po$ and, if integrated, $2x = PM$.[14]

9. The area of the rectangle of CB and PO is twice that of the hyperbolic area ABG. Since of course $Ee : Oo = eR : pO$, that is,

$$\frac{adx + xdx}{\sqrt{2ax + x^2}} : \frac{2adx + 2xdx}{a} = dx : pO,$$

therefore

$$pO = \frac{2dx \cdot \sqrt{2ax + x^2}}{a},$$

thus

$$CB \cdot pO = 2dx\sqrt{2ax + x^2},$$

and, when integrated,

$CB \cdot PO =$ double the hyperbolic area ABG.

10. The segment CP is bisected by the point A. Since of course $MP = 2x$, the result is that $BP = 2x + a$, $BP - BA$ or $AP = x + a = CA$.

11. The length of the curve EB is to the length of the curve MNO as the segment CB is to segment AG. That is because EB, that is, $\sqrt{2ax + x^2}$, is to MNO or

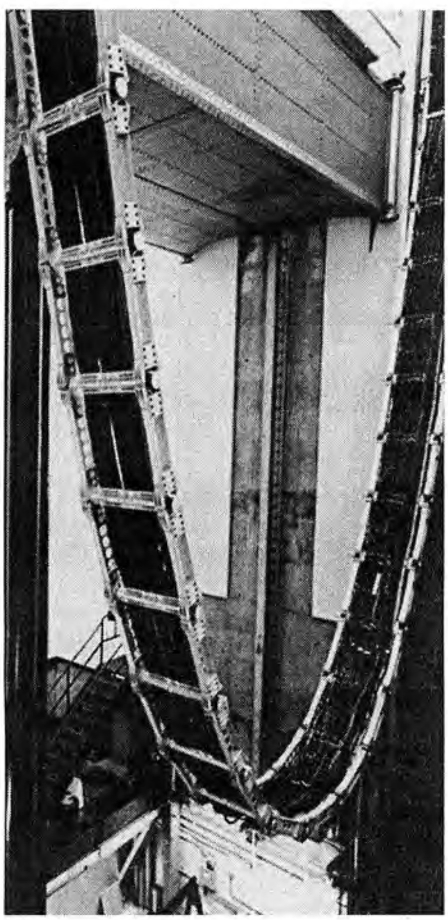
$$\frac{2ax + x^2}{a}$$

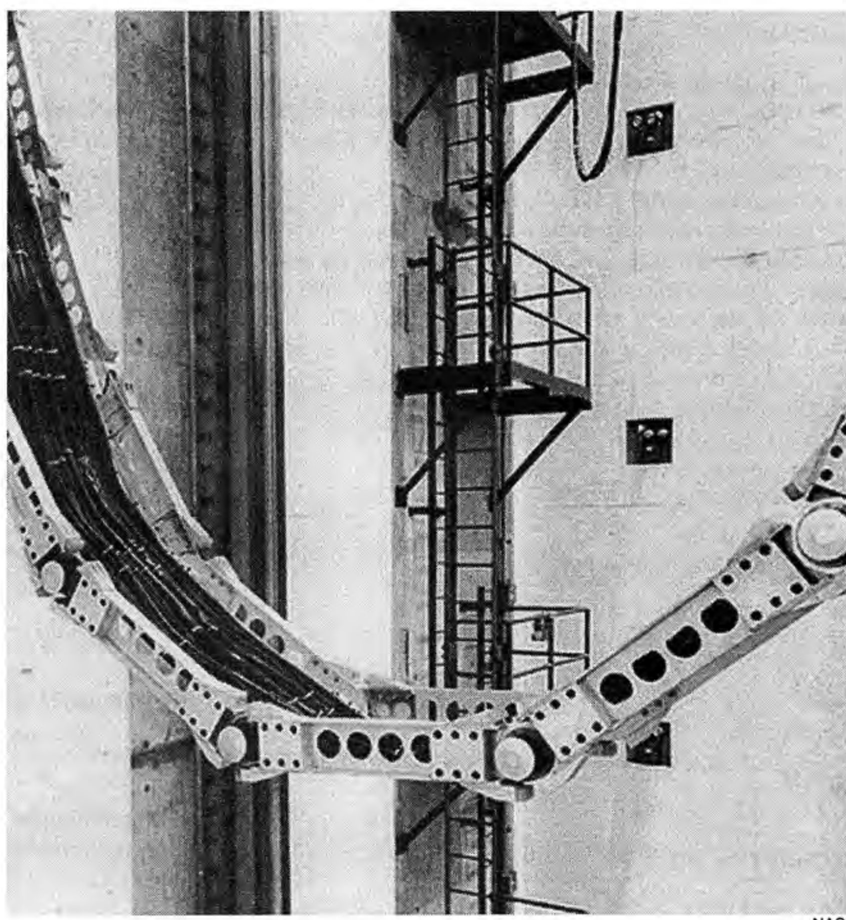
as a is to $\sqrt{2ax + x^2}$, and therefore as CB is to AG.

12. If the two rectangles AJ, AK are placed on AG (AJ is formed from the half transverse axis CB and the segment FG, and the area of AK is equal to that of the hyperbolic area BGA); and, from the vertex B along the axis, a segment BL equal to width KJ is drawn; then point L will be the center of gravity of the catenary EBF. This will be proven in another location.

13. If one imagines infinitely many curves drawn from E to F that are equal in length to the catenary EBF and *lays* them out as straight lines, and constructs individual vertical lengths at the individual points of the particular segment equal to the respective distances from the line EF, then of all areas formed in this manner, the greatest is that formed by the catenary.[15]

This will be proven with the help of the axiom that the center of gravity descends as far as it can.





NASA

Two huge chain catenaries used by in the testing of aircraft at NASA's Vertical Motion Flight Simulation Laboratory.

Notes

1. In Galileo's *Dialogues Concerning Two New Sciences* (1638), the catenary is discussed and its form compared to a parabola. Joachim Jungius (1669) showed that the curve is not a parabola, but he was not really able to define it. Jakob Bernoulli proposed the problem anew in May 1690 in the *Acta Eruditorum*, and then it was solved by Huygens, Leibniz, and Johann Bernoulli. [Kowalewski]

2. Let the force acting along AB be F_A, the force acting along CB be F_C, and the weight of P be F_p. The horizontal component of F_A is $F_A \sin\angle ABG$, opposing the horizontal component of F_C, which is $F_C \sin\angle CBG$; and F_p is the force of gravity on P, and only acts vertically. Because P is not moving horizontally,

$$F_A \sin\angle ABG - F_C \sin\angle CBG = 0,$$

or

$$F_A \sin\angle ABG = F_C \sin\angle CBG,$$

and so

$$F_A : F_C = \sin\angle CBG : \sin\angle ABG,$$

as stated in point 5 of this lecture. The vertical component of F_A is $F_A \cos\angle ABG$, pulling upward; the vertical component of F_C is $F_C \cos\angle CBG$, also pulling upward; and F_p, the weight of P, is of course pulling down. Because P is not moving vertically, we have

$$F_P - (F_A \cos\angle ABG + F_C \cos\angle CBG) = 0,$$

or

$$F_P = F_A \cos\angle ABG + F_C \cos\angle CBG.$$

Dividing both sides of the equation by F_C yields

$$\frac{F_P}{F_C} = \frac{F_A}{F_C}\cos\angle ABG + \cos\angle CBG.$$

We proved above that $F_A/F_C = \sin\angle CBG/\sin\angle ABG$, so we can substitute here and obtain

$$\frac{F_P}{F_C} = \frac{\sin\angle CBG \cos\angle ABG}{\sin\angle ABG} + \cos\angle CBG,$$

and multiplying $\cos\angle CBG$ by $1 = \sin\angle ABG/\sin\angle ABG$, and rearranging terms in the equation, we get

$$\frac{F_P}{F_C} = \frac{\sin\angle CBG \cos\angle ABG + \cos\angle CBG \sin\angle ABG}{\sin\angle ABG}.$$

Now $\angle CBG + \angle ABG = \angle ABC$, and the Greeks knew that

$$\sin(x+y) = \sin x \cos y + \cos x \sin y,$$

so we have

$$\sin\angle ABC = \sin\angle CBG \cos\angle ABG + \cos\angle CBG \sin\angle ABG,$$

and substituting,

$$\frac{F_P}{F_C} = \frac{\sin\angle ABC}{\sin\angle ABG},$$

or $F_p : F_C = \sin\angle ABC : \sin\angle ABG$, as stated in point 5. [Ferguson]

3. The force at B is a constant, expressible as the weight of a segment of chain labelled C, of constant length a (not related to point a). [Ferguson]

4. If the chain is of uniform density per unit length (call the density Q), then the weight of chain AB will be Qs, which increases or decreases as the chain $AB = s$ is lengthened or shortened; the force at B, which Bernoulli sets equal to the weight of a segment C of constant length a, will be Qa. Therefore, the weight of AB is to the force at B as Qs is to Qa, and therefore as s is to a. Bernoulli expresses this ratio of forces in terms of a ratio of lengths, so that it will be in a form solvable by the method of inverse tangents, as is shown below. [Ferguson]

5. Here y is considered an independent variable (instead of x). Accordingly, $d^2y = 0$ This aid for the conversion of independent variables is already found in Leibniz manuscripts of 1675.

Bernoulli cannot complete the calculation, because he lacks the logarithmic function. From

$$dy = \frac{adx}{\sqrt{x^2 - a^2}}$$

it follows that

$$y = a \log\left(x + \sqrt{x^2 - a^2}\right) + \text{const.}$$

or, if the axis system is displaced appropriately in the y-direction,

$$y = a \log \frac{x + \sqrt{x^2 - a^2}}{a}.$$

From this it follows that

$$x = \frac{a}{2}\left(e^{\frac{y}{a}} + e^{-\frac{y}{a}}\right).$$

The curve is therefore the catenary, which Bernoulli deals with in a later lecture. [Kowalewski]

6. For the equilateral hyperbola BC, $(x + a)^2 - y^2 = a^2$ or $y = \sqrt{2ax + x^2}$. Therefore $KC = \sqrt{2ax + x^2}$. If $BA = a$ is the mean proportional between KC and KD, then $KC/a = a/KD$ or $KD = a^2/\sqrt{2ax + x^2}$. Then, if the area of rectangle $AG = aAF$ is to equal the area of

$$HBKDJ = \int \frac{a^2\,dx}{\sqrt{2ax + x^2}},$$

then for the curve BE,

$$y = EK = AF = \int \frac{adx}{\sqrt{2ax + x^2}},$$

and

$$dy = \frac{adx}{\sqrt{2ax + x^2}}.$$

[Ferguson]

7. For the equilateral hyperbola,

$$\frac{dx}{y} = \frac{dy}{x} = \frac{xdy - ydx}{x^2 - y^2} = \frac{dx + dy}{x + y},$$

therefore

$$\frac{1}{2}(xdy - ydx) = \frac{a^2}{2}\, d\log(x + y)$$

and the hyperbolic sector

$$ABC = \frac{a^2}{2}\log\frac{x + \sqrt{x^2 - a^2}}{a}.$$

If this be compared with the formula in footnote 5,

$$y = a\log\frac{x + \sqrt{x^2 - a^2}}{a},$$

the correctness of Bernoulli's assertion is seen.

On page 37, col. 1, line 23, A must be replaced by B. [Kowalewski] [For this translation, the correction has been incorporated into the text.]

8. If the area of rectangle AG is equal to double the area of hyperbolic region ABC, then we have $aAF = 2(\text{area } ABC)$ or $y = EK = AF$

$$= \frac{2(\text{area } ABC)}{a} = \frac{2}{a}\left(\frac{1}{2}AK \cdot KC - \text{ area } BKC\right)$$
$$= \frac{2}{a}\left[\frac{1}{2}(x + a)\sqrt{2ax + x^2} - \int \sqrt{2ax + x^2}\, dx\right],$$

and $dy = \dfrac{adx}{\sqrt{2ax + x^2}}$.

[Ferguson]

9. The German edition has AE here, an error for BE. The expression, "the other endpoint E again will lie on the desired curve," taken in light of the two preceding paragraphs, indicates that BE is meant. This is, in fact, the same error that Kowalewski corrected on the previous page of the German edition: The vertex of the catenary had been mistakenly called A instead of B. See the last paragraph of footnote 7. [Ferguson]

10. "Hence one must seek a certain curve BL" whose *length* s as a function of x, has the differential

$$ds = \frac{dx\sqrt{2a + x}}{\sqrt{x}}.$$

Since $ds^2 = dx^2 + dy^2$,

$$dy^2 = ds^2 - dx^2 = \frac{(2a + x)\,dx^2}{x} - dx^2 = \frac{2adx^2}{x}$$

and

$$dy = \frac{dx\sqrt{2a}}{\sqrt{x}} = \text{ the differential of } KL,$$

that is, the y-coordinate of BL. So for BL,

$$y = \sqrt{8ax}.$$

[Ferguson]

11. The logarithmic curve is, because of the constancy of the subtangent, characterized by $y' = y/c$ [that is, $dy/dx = y/c$] and is therefore expressed by $y = be^{cx}$.

Because of its relationship with the logarithmic curve, Leibniz proposed to use the catenary in place of logarithmic tables, especially when travelling, because voluminous tables were inconvenient "to *schlep* across land and sea." [Kowalewski]

12. Definition of the subtangent: For a curve $y = f(x)$ with a line L tangent to it at point (x',y') the subtangent is the segment of the x-axis between the x-coordinate of the point of tangency (x',o) and the intersection of the x-axis and the tangent line L. [Ferguson]

13. If the length of $BE = s$ is considered a function of x, then

$$BE = s = \int ds = \int\sqrt{dx^2 + dy^2} = \int\sqrt{dx^2 + \frac{a^2dx^2}{2ax + x^2}},$$

which reduces to

$$\int\frac{(x + a)\,dx}{\sqrt{2ax + x^2}} \text{ or } \sqrt{2ax + x^2},$$

which is the y-coordinate AG of the equilateral hyperbola BG. [Ferguson]

14. Because

$$Ee = ds = \frac{(x + a)\,dx}{\sqrt{2ax + x^2}} \text{ and } ER = dy = \frac{adx}{\sqrt{2ax + x^2}}.$$

[Ferguson]

15. The proposed constructions may be restated in this form: Suppose the catenary EBF, in Figure 9, to be a chain with very fine links. Step 1. At various points along EBF, cut rods that extend vertically from each chosen point on the catenary curve to the horizontal EF. Attach each rod to the link it touches. Now extend the chain as a straight line. Use the free ends of the still-vertical rods to define a line. An area is now enclosed by the straight chain and the line just defined, and can be measured. Step 2. Form any number of other curves whose end-points are E and F, and whose length is the same as the catenary EBF. Repeat for these curves the procedure described in Step 1.

Bernoulli asserts that the area derived from the catenary is the greatest of all such areas. [Ferguson]

The Significance of the Catenary

by Bruce Director

It is indicative of the level of today's cultural decay, that scientist and layman alike are generally ignorant of the true history and principles of G.W. Leibniz's infinitesimal calculus. It is a matter of vital interest for the future of science and, more generally, civilization as a whole, that this situation be remedied quite rapidly.

Fortunately, this process is already under way through the revolutionary educational program of Lyndon LaRouche's international youth movement. The accompanying first English translation of the concluding section on the catenary, from Johann Bernoulli's 1691 "Lectures on the Integral Calculus," provides a vital resource for that effort.

The significance of the catenary curve emerged in modern times with the construction of Brunelleschi's famous Dome over the church of Santa Maria del Fiore in Florence, Italy. Built between 1420 and 1426, it was the largest free-standing dome constructed until that time. To build the dome without scaffolding, Brunelleschi utilized the least-action properties of the hanging chain, both to guide the curvature of the bricks, as well as to stabilize the Dome's structure.

The successful construction of the Dome indicated that the hanging chain expressed a universal physical principle whose investigation involved the fight between the successful Socratic method of Kepler, Leibniz, and Bernoulli on the one side and the failed empiricist methods of Paolo Sarpi, Galileo, and Euler on the other.

Brunelleschi's Dome at the church of Santa Maria del Fiore in Florence, Italy, built between 1420 and 1426. Brunelleschi used the least action principle of the catenary as a guide for the curvature of the bricks, and to stabilize the structure.

Kepler's Discovery and Kepler's Problem

In discovering the elliptical nature of the planetary orbits, Kepler set the stage for the development of the infinitesimal calculus. Kepler rejected the method of Ptolemy, Copernicus, and Brahe, who all adopted the Aristotelian dogma that knowledge of physical principles was impossible, and that science can only concern itself with the mathematical description of appearances. Consequently, Ptolemy, Copernicus, and Brahe, although positing wildly different mathematical models, all accepted the restriction that planetary motion must conform to perfectly uniform circular action.

In arriving at the elliptical orbits on the basis of his physical hypothesis concerning universal gravitation, Kepler showed that the planet's motion was always changing. That change was not the result of any innate property of the planet, but was the effect of the principle of universal gravitation, which was acting on the planet, from outside the domain of sense perception, at every

by Susan Schartzenberg, © Exploratorium, www.exploratorium.edu

Children exploring the catenary and its relationship to the arch, at the San Francisco Exploratorium.

moment of the planet's action. Therefore, the planet's action had to be measured as a function of this principle of change.

Kepler's attempt to solve this problem led to the formation of his famous principle of equal areas. But, Kepler's approach contained a paradox. Kepler could measure where the planet had been, but the same method could not measure where the planet would be. This problem, known as "The Kepler Problem" required the development of a new type of mathematics, which Kepler demanded in *The New Astronomy*.

It was Kepler's challenge that provoked Leibniz to develop the infinitesimal calculus. In collaboration with Johann Bernoulli and Christiaan Huygens, Leibniz applied his calculus to the solution of many physical problems, such as the catenary.

The problem of the catenary exemplifies the superiority of Leibniz's method over the neo-Aristotelianism of Sarpi, Galileo, et al. Galileo had insisted that the shape of the hanging chain was a parabola, because the visible appearance of the chain and the parabola were similar. However, careful physical measurements by Joachim Jungius, and a later analysis by Huygens, demonstrated that Galileo was wrong.

Huygens and Jakob Bernoulli (Johann's brother) subsequently put out a challenge to determine the principle governing the hanging chain, which Leibniz recognized as an expression of his universal principle of least-action. Both Leibniz and Bernoulli contributed to the discovery of the catenary principle. Leibniz's discovery was published in the *Acta Eruditorum* in June 1691.

In the accompanying excerpt from Bernoulli's *Lectures,* Bernoulli develops his own original application of Leibniz's calculus to the catenary curve, and he shows the equivalence of his results to those of Leibniz.

Like Kepler—but unlike Galileo—Bernoulli considers the shape of the hanging chain to be merely the visible effects of an unseen universal physical principle. That principle is acting on the chain at every infinitesimal point. How that principle is acting, Bernoulli shows, can be expressed by a differential equation in the manner of Leibniz's calculus. However, as Bernoulli recognizes, his differential equation for the catenary curve can not be expressed by an algebraic expression.

In his treatment, Leibniz showed that Bernoulli's differential equation could be expressed as the arithmetic mean between two opposite exponential curves. Leibniz also demonstrated the connection between this expression and the quadrature of the hyperbola, hence the now common denotation of the catenary by the hyperbolic cosine.

Like Socrates, LaRouche has emphasized in the education of his youth movement, that the only way for a student to get to know something is to relive the discovery as if it were original to the student. This is best achieved, LaRouche says, in discussion groups of not less than 15 and not more than 25 participants.

The accompanying piece by Bernoulli, taken along with Leibniz's own work and LaRouche's more extensive writings on the subject[1] provide an excellent basis for such educational work.

Notes

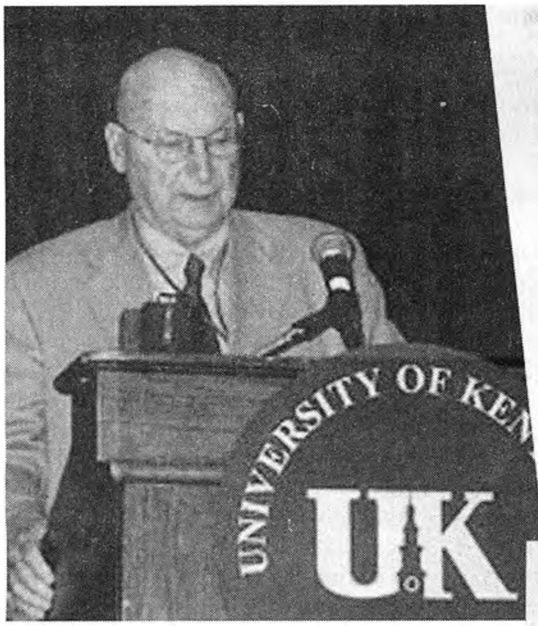
1. See, for example, Lyndon H. LaRouche, Jr., "Visualizing the Complex Domain," *21st Century,* Fall 2003, p. 24, and "The Pagan Worship of Isaac Newton," *21st Century*, Winter 2003-2004, p. 18.

For Further Reading

G.W. Leibniz, "Discourse on Metaphysics" (1686). In Leroy Loemker, ed. *Gottfried Wilhelm Leibniz Philosophical Papers and Letters* (Chicago: Chicago University Press, 1956), pp. 464-506, and in other locations.

"Preface to Leibniz's *New Essays on Human Understanding,*" by Abraham Gotthelf Kästner, *Fidelio,* Spring 2003, p. 79.

Lyndon H. LaRouche, Jr., "Science for Teachers: Visualizing the Complex Domain," *21st Century,* Fall 2003, p. 24.



The University of Kentucky website

The Pentagon's éminence grise, Andrew Marshall, has been the source of key military-strategic blunders for more than three decades. His latest is an abrupt climate change scenario, in which there would be new wars over scarce resources.

From 'War on Terror' To 'Climate Warfare'

by Ralf Schauerhammer

Under the headline "Now the Pentagon Tells Bush: Climate Change Will Destroy Us," the London *Observer*'s Feb. 22 issue brought sensational news: "Climate change over the next 20 years could result in a global catastrophe costing millions of lives in wars and natural disasters. . . . A secret report, suppressed by U.S. defense chiefs and obtained by the *Observer,* warns that major European cities will be sunk beneath rising seas as Britain is plunged into a 'Siberian' climate by 2020. Nuclear conflict, mega-droughts, famine and widespread rioting will erupt across the world. . . . The document predicts that abrupt climate change could bring the planet to the edge of anarchy as countries develop a nuclear threat to defend and secure dwindling food, water, and energy supplies. The threat to global stability vastly eclipses that of terrorism."

Just how the *Observer* obtained this "suppressed" report, isn't nearly as mysterious as the editors make it out to be. The report in question is titled "An Abrupt Climate Change Scenario and Its Implications for United States National Security." It was put together under the direction of Peter Schwartz, director of the Global Business Network, and was a working draft for a more extensive article titled "Climate Change for a National Security Threat," which appeared in *Fortune* magazine's Jan. 26 issue.

What's more interesting, is that Schwartz's paper had been commissioned (and slipped to the press) by a central planning group inside the U.S. Defense Department led by Andrew Marshall.

For more than three decades, Marshall has headed up the Office for Net Assessments, and is considered to be Pentagon's *éminence grise*. Most of the key U.S. military-strategic blunders of recent decades can be traced directly to him—for example, the utopian imperial "Revolution in Military Affairs," which can be best described as the military equivalent of the "New Economy" swindle. And it also comes as no great surprise, that Marshall has harbored a decades-long hatred against Lyndon LaRouche and his ideas.

In the very first sentence of the *Fortune* article, parallels with the "War Against Terrorism" are clearly drawn: "Global warming may be bad news, but let's face it, most of us spend as little time worrying about it as we did about al-Qaeda before 9/11. Like the terrorists, though, the seemingly remote climate risk may hit home sooner and harder than we ever imagined."

Also interesting is the political significance which the *Observer* attributes to the report: "So dramatic are the report's scenarios . . . that they may prove vital in the U.S. elections." Because, amazingly, the report was commissioned "by influential Pentagon defense advisor Andrew Marshall, who . . . was the man behind a sweeping recent review aimed at transforming the American military under Defense Secretary Donald Rumsfeld." And coming thus out of that corner, it means big trouble for Bush, reports the *Observer:* "The findings will prove humiliating to the Bush Administration, which has repeatedly denied that climate change exists. . . . Democratic frontrunner John Kerry is known to accept climate change as a real problem. . . . The fact that Marshall is behind its scathing findings will aid Kerry's cause."

The Bush Administration cannot entertain the false hope that the issue might not emerge as a major one over the next few months, because on May 28, a new film, "The Day After Tomorrow," is set to hit the box offices. It enacts a sudden and catastrophic entry into a new Ice Age, with scenes just as gripping as were those of another film made 21 years ago, "The Day After," about the aftermath of a nuclear strike against the United States.

The 'Scientific' Background

Just how hastily this new scare campaign has been cooked up, is demonstrated by its flimsy scientific underpinnings. *Fortune*'s account refers to Schwartz's "secret report" in these terms: In connection with the World Economic Forum in Davos, Switzerland, there was "a session at which Robert Gagosian, director of the Woods Hole Oceanographic Institution in Massachusetts, urged policymakers to consider the implications of possible abrupt climate change within two decades." The reference is fitting, because it was those theses presented by Gagosian to the World Economic Forum in January 2003, which Schwartz has uncritically adopted as his own.

According to Gagosian's theory, global warming will lead to a steady increase in the amount of melt-off water in the world's oceans, which, in turn, will cause the warm Gulf Stream to suddenly change course, such that it will no longer reach into the Northern Atlantic. This, in turn, will trigger a sudden global climate change, which will manifest itself differently in various parts of the globe—but always with negative effects: In cold regions, it will get even colder, and in warm regions, drought and desertification will increase, whereas in regions with storms and monsoon rains, the intensity of those weather events will increase catastrophically.

All this, of course, can be modelled and precalculated by computers—but that still doesn't make science fiction into real science, by a long shot.

In fact, there's nothing new about this theory. The basic outline was set forth back in 1997,[1] and in 2001, Gagosian made an identical presentation on "The Economic and Social Consequences of Global Environmental Changes." But back then, Peter Schwartz was apparently concentrating on other things, and this crucial issue somehow escaped his notice. Indeed, back then—shortly after Sept. 11, 2001—Peter Schwartz wrote the following on the Global Business Network's website: "If it is true, as many are arguing, that World War III has begun, then it is critical to understand what the war is about. . . . Osama bin Laden is only the expression of a much bigger problem. . . . Throughout the Islamic world, from Pakistan to the Middle East and North Africa, there are very few successful nation-states. Most of them have failed. . . . They need an enemy to justify their failure. . . . There are at least 10 key countries, in three groups, that need to be dealt with in any broad campaign against terrorism." The countries named include Sudan, Afghanistan, Saudi Arabia, Iran, and Syria. According to Schwartz, "Our targets must be both the terror network and the governments that support it. We much punish the evildoers by eradicating them."

But now that the neo-conservatives' preventive warfare doctrine has demonstrably failed to have the desired effect, Schwartz has suddenly discovered that the world's climate poses a "threat to global stability" which "vastly eclipses that of terrorism"!

The Political Motive: 'Perpetual War'

But Schwartz goes further, putting his own overlay on top of Gagosian's abrupt climate-change theory and "Weather Report for 2010-2020." Gagosian's forecast can't be perfectly accurate, but nevertheless, Schwartz writes, "there appears to be general agreement in the scientific community that an extreme case like the one depicted below is not implausible." In view of the fact that even local short-term weather forecasts are fraught with inaccuracies when they concern situations involving rapid transitions between high and low pressure, there certainly does not exist any such "general agreement in the scientific community" as Schwartz claims.

But this fib is small potatoes, compared to some of his other assertions. For example, Schwartz predicts that a catastrophic climatic reversal will occur as early as 2007, and on that basis, he spins out an end-of-the-world scenario fitting for a new movie script.

And in fact, it's easy to see from the overall style of his "secret report," that Schwartz has been functioning for some time now as an advisor to Hollywood producers, for example, for Steven Spielberg's film "Minority Report." Schwartz gasps, "As glacial ice melts, sea levels rise . . . ocean waves increase in intensity, damaging coastal cities. Additionally, millions of people are put at risk of flooding around the globe. . . . Fisheries are disrupted as water temperature changes cause fish to migrate to new locations. . . . Drought persists for the entire decade in critical agricultural regions and in the areas around major population centers in Europe and North America. . . . Winter storms and winds intensify," and so on.

By floating this climate catastrophe scenario, Schwartz has laid the groundwork for his main political clincher: "As abrupt climate change lowers the world's carrying capacity, aggressive wars are likely to be fought over food, water, and energy."

And wouldn't you know it? Just in time, a new book has come out by Harvard professor Steven LeBlanc, which "describes the relationship between carrying capacity and warfare." According to LeBlanc, future warfare is going to be a bit different: "Advanced states have steadily lowered the body count. . . . Instead of slaughtering all their enemies in the traditional way, for example, states merely kill enough to get a victory and then put the survivors to work in their newly expanded economy. . . . All of that progressive behavior could collapse if carrying capacities everywhere were suddenly lowered drastically by abrupt climate change. Humanity would revert to its norm of constant battles for diminishing resources. . . . Once again warfare would define human life."

Given the existence of weapons of mass destruction, this scenario would imply the extermination of most human beings on this planet. According to Schwartz, "In this world of warring states, nuclear arms proliferation is inevitable. . . . China, India, Pakistan, Japan, South Korea, Great Britain, France, and Germany will all have nuclear weapons capability, as will Israel, Iran, Egypt, and North Korea."

Now, some dolts might have a crazy idea that the new trend toward proliferation is the result of Cheney and Rumsfeld's strategy of preventive nuclear warfare using so-called "mini-nukes." But strategic thinker Peter Schwartz sets us straight on that one: On the contrary, it's all the weather's fault! And Andrew Marshall has nothing but applause for such brilliant thinking.

Eurasian Land-Bridge Vs. Malthus

Incredibly, the entire "secret report" contains not a single solitary word on the significance of the economy for national security—despite the fact that only a few years ago, Peter Schwartz himself made some rather pithy comments on the course of the world economy. In his 1999 book *The Long Boom,* which he co-authored with Peter Leyden, he forecast a coming period of sustained growth, during which the world economy would double in size every 12 years, and would bring increasing prosperity to billions of people. Up through 2020, the new information technologies would have spread the fundamental economic and political values of the U.S.A. into all parts of the planet, and problems such as poverty, cancer, and global warming would have been either eliminated or substantially reduced, according to this seer.

Such propaganda for globalization and "free-trade optimism" is merely one side of the neo-liberal coin; on its flip side, one can clearly distinguish the ugly face of Malthusian wars of extermination under conditions of reduced carrying capacity.[2] On July 13, 2000, Schwartz told a reporter for *Executive Intelligence Review:* "In 1986 [i.e., before he had published his optimistic boom book], I did a study on this for AT&T, Royal Dutch Shell, and Volvo. We concluded that people who have AIDS in Africa should not be kept alive; they spread the disease. It is better they should die quickly." Here he's showing the kind of social Darwinism, usually allied with outright racism, that is typical of such neo-liberals. It would be interesting to know whether Schwartz now recommends the same prescription for AIDS victims in the United States and Europe.

In Europe, where the political elite has been more receptive to Malthusian ideas, there could arise the false illusion that Europeans could have an important role as junior partner, by "overcoming the climate-related security threats" concomitant with decreasing "carrying capacity." But beware! Malthus concocted his theory of limited carrying capacity in order to establish a political basis for abolishing centuries-old social laws; to rescue the economically bankrupt British Empire; and also, at the same time, to deprecate the successes of the young American republic. So, now, apparently, dismantling social services and protections has once again become the "in" thing.

The actual alternative to all this, both economically and from the standpoint of national security policy, is to establish a republican economy according to the principles of physical economy, as set forth by economist and U.S. Presidential candidate Lyndon LaRouche. Europe should not allow itself to be seduced into either a false "War Against Terrorism," or a Malthusian war of extermination based on a fraudulent theory about of the Earth's "carrying capacity." Instead, Europe should not waver in adopting the concept of cooperation in constructing the Eurasian Land-Bridge, and in doing all that is required to rescue Africa out of its current pit of despair.

Ralf Schauerhammer is an editor of the German-language science magazine Fusion *and an organizer with the LaRouche political movement in Germany. He is the co-author of* the Holes in the Ozone Scare: The Scientific Evidence That the Sky Isn't Falling, *published by* 21st Century *in 1992.*

Footnotes

1. See R.B. Alley, T. Sowers, P.A. Mayewski, M. Stuiver, K.C. Taylor, and P.U. Clark, "Holocene Climate Instability: A Prominent, Widespread Event 8,200 Years Ago," in *Geology,* Vol. 26, No. 6, 1997.
2. Ralf Schauerhammer, "Warum es wirklich keine Grenzen des Wachstums gibt" ("Why There Really Aren't Any Limits to Growth"), in *Neue Solidarität,* No. 15, April 10, 2002. This appeared in English in *21st Century Science & Technology,* Spring 2002.

Maupertuis: The Man Who Tried to Flatten Leibniz

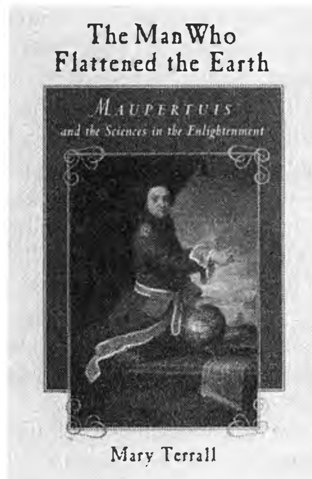
by David Shavin

The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment
by Mary Terrall
Chicago: University of Chicago Press, 2003
Hardcover, 408 pages, $39.00

In the 18th Century, Pierre-Louis Moreau de Maupertuis was mainly known for two things: his expedition to Lapland to make geodetic measurements (showing that the Earth is flattened at the poles, and not at the equator), and his making a fool out of himself and the Berlin Academy of Science, in presiding over flagrantly political operations that attempted to eliminate the science of Gottfried Leibniz. The former accomplishment was largely a success of public relations, while the latter was so ugly, that it both poisoned Maupertuis's remaining days, and failed in a rather happy fashion.

Author Mary Terrall, an assistant professor of history at the University of California at Los Angeles, seems to have chosen to focus on Maupertuis because she finds that successful public relations is, for the science student of the 21st Century, the critical lesson to draw from his life. She thinks that the earlier, 1992 revival of Maupertuis, (David Beeson's *Maupertuis: An Intellectual Biography*), in trying to assess Maupertuis in terms of the status of his ideas, fails to appreciate his social skills and talents.

In following Maupertuis's movements and choices, Terrall has performed the useful task of showing how Maupertuis prostituted himself—although it certainly appears that she would have a new generation of scientists be seduced into the same practices. Maupertuis was quite adroit at flattery, at impressing women at salons, and evidently also in boudoirs. She quotes the Abbé Le Blanc: "M. de Maupertuis played his guitar at the toilette of duchesses and at the suppers of ministers. They have paid him with a position without responsibilities that was created just to give him 1,000 crowns more than he already had."



But Maupertuis's facility would be extended beyond the salon.

Maupertuis's Career

Maupertuis's father was one of the pirates of Brittany, who succeeded in dispensing with his ships and converting to financial piracy on land, in such speculative financial ventures as the infamous "South Seas Bubble." His first-born, Pierre-Louis, was educated to attend the salons of Paris.

Maupertuis's preference for gamesmanship over physical causality was established in one of his first papers for the Academy, his 1726 "Sur une quéstion de maximis et minimis" (On a question of maximum and minimum). Here, as Terrall explains, he was "to find trapezoids of greatest and least area, given certain conditions for the lengths of the sides." He wrote an algebraic formula, differentiated it, and obtained not two, but four solutions—two of which were not trapezoids. Normally, such an event need not be fatal, should one simply go back and re-examine the axioms that misled one to propose such an overly broad algebraic encapsulization.

But Maupertuis evidently was wired differently. He proudly claims: "Nothing shows better the advantage of algebra over geometry in the solution of problems than this abundance with which it gives not only what we had meant to ask of it, but also everything depending on the same conditions and that we did not think of asking it."

This weakness for the magical fecundity of formalisms surely was not overlooked by whomever promoted his next career move. In 1728, Maupertuis made an unusual visit to the Newtonian establishment of London, where he was rapidly made a member of the Royal Society within about one month of his arrival. (It would take him a few more months, after leaving London, to cure himself of the syphilis that he had contracted there.)

Deploying against Bernoulli

Maupertuis then launched into his most difficult project—a three-year deployment (1729-1732) against the still-active Johann Bernoulli, Gottfried Leibniz's closest scientific collaborator. In 1724, Bernoulli had been slighted by the Paris Academy, in its essay contest promoting a "hard ball" (or "billiard ball") notion of physical causality. Bernoulli's essay showed that an analysis based upon the elasticity of substance, instead of a fundamental impenetrability, was powerful and correct. It was obviously the superior essay of the contest, but it was passed over in favor of Colin Maclaurin's Newtonian approach.

Bernoulli, based in Basel, had been trying for five years to persuade the Paris Academy to engage in a healthy discussion of the underlying issues. Maupertuis offered himself as Bernoulli's advocate in Paris. He then took advantage of the position to direct Bernoulli to demonstrate the main weaknesses in Newton, and indicate the lines of improvement in the product, so that Newton could be marketed outside of Great Britain.

Maupertuis's marketing of Newton in France exploited the unexamined axioms in Descartes. His opening salvo, in 1732, *Discourse on the Various Shapes of the Celestial Bodies, with an Exposition of the Systems of Mssrs. Descartes and Newton,* argued that Newtonian "attraction being no less possible in the nature of things than [Cartesian] impulse, we can use both of them." In France, Maupertuis would offer his gentleman's agreement, whereby each faction's unexamined axioms and occult qualities would be allowed to circulate undisturbed as the debased currency of the scientific realm.

Voltaire joined Maupertuis's project that same year (1732), writing: "Your first letter baptized me in the Newtonian religion, your second gave me my confirmation. I thank you for your sacraments." For the next 20 years, these two, along with their shared mistress, Emilie du Chatelet, led the proselytization for Newton on the continent.

Perverting 'Least Action'

However, in the 1740's, when Maupertuis accepted the appointment to head the Berlin Academy, he had to dig deeper into his grab-bag of tricks to attempt to root Leibniz out of Germany. He would combine with Leonhard Euler in "glove-and-fist" operations, where sophistry and naked threats were intermixed.

First, Maupertuis adopted the Leibnizian phrase, "least action," for his peculiar transformation of values in the Berlin Academy of Science. For Leibniz, a "least action" principle reflects the fundamentally good workings of God, whereby the Creator's handiwork betrays a pattern that is increasingly intelligible to man, made in His image. God works intelligibly, not randomly. For Maupertuis, such a principle reflects God's laziness.

In the specific case of the refraction of light, for example, from a less dense to a more dense medium, the light follows a "least action" pathway. However, instead of taking the path of least distance, as in the case of reflection (the case of a "zero" change in the density of medium), the light takes the path of least time. For Leibniz, this has several implications; namely: Action is more fundamental than any resultant distance; reflection is a derived (and collapsed) case of refraction; and sine/cosine—or circular—values are more real and causal than mere length—or linear—values.

Maupertuis explicitly reverses this. In the paper which was the basis of his inaugural address to the Berlin Academy, Maupertuis asks: "What preference could it [light] have for time over distance?" He argues for the more "common-sensical" notion that what we think we can see—length—must be primary; and the somehow metaphysical notion of circular constructs (sines or cosines) must be derived from the linear.

Académie Française

Pierre-Louis Moreau de Maupertuis (1698-1759): An advocate of the senses, the sensual, and Issac Newton, and an antagonist of the ideas and method of Leibniz and Bernoulli.

For Maupertuis, God has already invented the law of reflection (of least distance). This must be primary for God, because we stumble upon it first. Therefore, God would not be acting in a "least action" sort of way if he were then to invent a higher order law of refraction! So, with regard to refractive phenomena, it seems that man simply has some sort of confusion of his senses; and the road to clarity involves his getting back to the basics of scalar lengths—and, in general, the basics of the five animal senses.

In 1750, Maupertuis attempted to put his new and improved "least action" principle on a royal pedestal in Berlin, by publishing a particularly ornate presentation of this mess, his *Cosmologie*. But in 1751, a Professor Samuel Koenig (a former student of Bernoulli and Christian Wolff) issued a public challenge, correctly asserting that Leibniz had developed the "least action" principle, and that it was not what Maupertuis was peddling. It was for Euler to bring down the fist, with a public trial in 1752 that railroaded Koenig. But its heavy-handedness demoralized the Berlin Academy and disgraced Maupertuis, who began to suffer illnesses that kept him from public duties. It also fired up two young geniuses, Gottlob Lessing and Moses Mendelssohn, to come to Leibniz's defense, and to successfully ridicule the folly of the science dictators.

In sum, from 1746 to 1755, Maupertuis and Euler had assaulted Leibniz's legacy at the Berlin Academy, in operations that included: the "least action" charade; a rigged Academy 1746-1747 "contest" against Leibniz's concept of the monad; and another 1753-1755 "contest" designed to reduce Leibniz's concept of "the best of all possible worlds" to the amoral sophistry of Alexander Pope, that "all [that is] is for the best." Lessing and Mendelssohn matured from 17-year-olds to 26-year-old men, forged in battle against Maupertuis's sophistical truth-hating rule, and, in their own way, they proved yet again that it was indeed the best of all possible worlds.

Maupertuis never recovered.

The Leibniz Gap

Mary Terrall probably has done more work on Maupertuis than anyone in history, including original translations of many French and German documents. Unfortunately, she is largely illiterate with regard to Leibniz—and that does cause a few problems when one's subject is put forth as the leading antagonist to Leibniz. Among a voluminous list of sources that she has read, her only listing for her study of Leibniz is Philip Wiener's 1951 English-lan-

Gottfried Wilhelm Leibniz
(1646-1716)

Johann Bernouilli
(1667-1748)

guage *Selections.*

When Terrall is concerned, for example, to connect Maupertuis's use of the term "perception" with his reading of Leibniz's *Monadology,* she prefers to use Wiener's English translation of this sensitive French text, despite her habitual use of French texts. At times, matters become a bit ludicrous. She begins a footnote, "On Leibniz's vision for the Berlin Academy, see. . ." and then she proceeds to cite a commentator's 23-page article from a 1996 *Isis* magazine, instead of simply referencing Leibniz's own (much shorter) article on his idea for his Academy.

There is no blushing here, just deeply ingrained habit. No one is supposed to actually study Leibniz, in the sense of having an open honest relationship with Leibniz's works. As such, Mary Terrall herself is a typical, modern-day scholarly victim of what the Maupertuis operation originally set out to accomplish.

Again, in the critical section on Maupertuis's treatment of Leibniz and Fermat on refraction and "least action," Terrall completely misses the point. She explains the preference of Maupertuis's God for matter over action: "God prefers a world functioning economically, where all changes or motions cost the least 'expenditure.' " The implicit assumption is that action is measured in terms of the less "expensive" matter, and/or that God prefers entropic dead matter to action.

In this section, Terrall seems to rely on on A.I. Sabra's *Theories of Light from Descartes to Newton,* which follows Euler's secondary argument that Leibniz really assumed that light moved faster in a denser medium, and that he differed from Fermat on the matter. She would have done better to have read the short analysis of light moving through increasingly more-dense media, in the historic collaboration between Leibniz and Johann Bernoulli, known as the brachistochrone problem.

In fact, in 1742, Bernoulli, as an old man, republished that same 1696-1697 brachistochrone material that he had instructed Maupertuis on back in 1730. And just two years later, in 1744, Maupertuis wrote his contrary version of the same. Because this is just the sort of textual history that Terrall otherwise specializes in, it only emphasizes what a massive blind spot she has in areas of basic literacy of Leibniz's work and thought.

Deeper into the Leibniz Pit

Terrall believes that she is correcting the record, where the 1992 Beeson biography had too simply assumed that Maupertuis was anti-Leibniz. "Beeson exaggerates Maupertuis's anti-Leibnizian views," she writes, whereas she presents Maupertuis as more even-handed during the first big attack against Leibniz at the Academy. But what Terrall succeeds in recounting is how Maupertuis relied upon Euler to do the dirty work, while he kept at arm's length.

Simply summarized, the anti-monad contest was launched in the first weeks of Maupertuis's presidency of the Academy in 1746, and Maupertuis ran cover for Euler, as Euler ran the committee that chose whatever anti-monad essay was available. The controversy was massive, and years later, Euler bragged about the protests of the Leibnizians.

Terrall's pains to paint Maupertuis as an innocent bystander in all this, ensnare her, rendering her account both weak and biased. For example, she asserts that Euler's early public declaration to the potential essayists as to the anti-monad orientation of the judges, was somehow counterbalanced by protests registered after the essays had been written. Her phrase is that there was an airing of "the whole controversy before the essays had even been collected by the prize commissioners."

But the essays had largely been written. She couldn't possibly think that this would cure the bias; but she could think it were important for Maupertuis to appear well-intentioned.

Terrall claims a more dispassionate view of Maupertuis's attitude toward Leibniz, a view acknowledged to stem from Ernst Cassirer, the Marburg neo-Kantian who taught at UCLA during World War II, and who said that Maupertuis was close to Leibniz. Maupertuis, Terrall says, simply "substituted physical points for Leibniz's metaphysical points, transferring the properties of monads to material particles and undercutting the foundations of Leibniz's system."

What must she understand of Leibniz's concept, if she also thinks this substitution a minor matter? And, in fact, this line was almost exactly the same as Euler's public threat referred to above—that monads could not be metaphysical, as only materiality could be allowed to account for causality.

With friends like this, one doesn't lack for enemies.

Terrall's supposed improvement upon the account of Cassirer is based upon the realization that he doesn't "address the ambivalence of Maupertuis toward Leibniz, which is related to his position in Berlin." It turns out that Maupertuis's operations against Leibniz, and his shocking thuggery against the poor Professor Koenig, were psychological abreactions, the result of his guilt in taking over the Berlin Academy from Leibniz. We can assume that modern day science controllers may also experience such abreactions, but now they might be understood and, perhaps, ameliorated.

The 'Science' of Seduction

In the final analysis, Terrall's praise for Maupertuis is that he was a master of seducing the ruling elite. Her account of Maupertuis's 1744 *Venus physique* displays the author at the height of his art. At the peak of his stature and sinecures in France, and in the midst of his work on refraction and "least action," Maupertuis instructs and entertains the upper class on the latest curiosity, an albino African boy displayed in Paris.

Maupertuis's biology and genetics lessons for ladies, first invites the (idealized female) reader to consider her own body, and then begins to explain that pleasure drives all, and that the sperm does not impregnate the egg, but genetic material comes from intermingled juices: "She who charmed him ignites with the same fire that burns him; she gives herself up to its transports; and the happy lover rapidly traverses all the beauties that overpowered him. He has already arrived at the most delicious spot. Oh, unfortunate man, whom a mortal knife [castration] has deprived of that state! If the blade had ended your life, it would have been less deadly. . . . In the human species, pleasure makes everything else disappear before it; in spite of a thousand obstacles to the union of two hearts and a thousand torments that are bound to follow, pleasure directs the lovers to the goal nature intended."

After establishing this pleasure-principle, and going on in this vein about the mating habits of various animals, he proudly announces: "I have searched several times with an excellent microscope to see whether there aren't similar animals [as in sperm] in the fluid that women produce."

Having revealed his bold research methods, his remaining audience is now prepared for the dizzying secret of the Newtonian attractive force. Not only are all the particles under the microscope driven by animal instinct, each for the other, but he: "cannot help pointing out that these forces and these affinities are nothing other than what other more daring philosophers call [Newtonian] attraction. This ancient term, revived in our times, at first shocked those scientists who thought they could explain everything without it."

Animal instinct is the key to Newtonian gravity; and, as such, we can dance all around it and play with it and tease each other about it, but we should no more ask for an unwrapping of the workings of gravity than we should probe any deeper into the behavior of human bodily fluids. Or, we all depend upon occult forces.

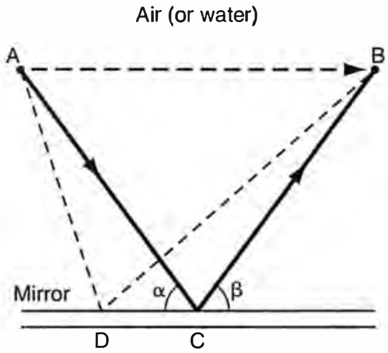
Terrall summarizes Maupertuis's *Venus physique* saying: "The reader is left reflecting on the animality of human desires and behavior, within the highly stylized and eroticized framework of polite society and fashionable literature. The hybrid genre of the book suited the speculative content, more provocative than definitive . . . but nevertheless claiming an authenticity for its interpretation of phenomena." Ironically, this is almost a clinical description of Terrall's own book, except that her subject is not the dance of sex, but the dance of the so-called scientists in pursuit of a career.

Terrall's conclusion emphasizes the lessons for today's budding scientists: "[M]aking an identity in science under these circumstances entailed speaking simultaneously in distinct but related voices. The voice of the loyal subject and servant of the state alternated with that of the unfettered mind in pursuit of disinterested truth. Maupertuis saw academies as vehicles for receiving patronage from the highest circles of government and as a framework for dispensing patronage himself. His obsession with marks of honor, such as titles and pensions, betrayed his desire to assert the noble status of his calling. For Maupertuis, being a man of science was the means to reputation, and even glory."

The art of Terrall's book consists in her attempt to make all of this sound like a good thing.

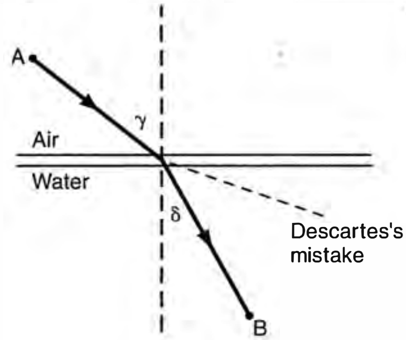
Ironically, were the author to have looked out her window at UCLA at the right time, she would have seen members of the LaRouche Youth Movement out in the open air on campus, with pedagogies on the crucial difference in the cases of the reflection and the refraction of light (that is, that action is of a higher order than distance). There, the minds of excited students could focus on the change in the *idea* of least action itself, as a reflection of the "least action" characteristic of their minds.

Terrall would have witnessed—through the youth dialogues—scientific discourse and inquiry as a means for equipping human beings for pursuing truth and making history. And instead of being the author who depressed her students and readers about *The Man Who Flattened the Earth,* she might have reappraised her extensive familiarity with Maupertuis's words and actions, and written the tragi-comedy, *The Man Who Tried to Flatten the Mind.*



REFLECTION

Shown is least action from A to B, given some reflection off a surface. Angle α = angle β. Least distance is seen; least time is implicit.



REFRACTION

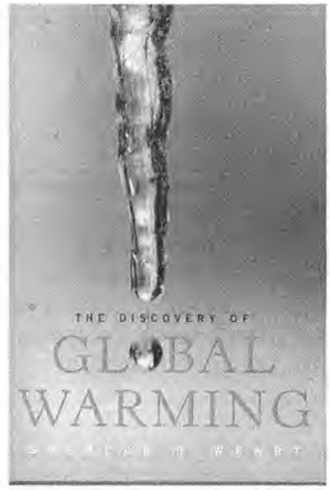
Light minimizes the time of the trip —not the distance—from A to B. Sin γ/sin δ is the ratio of the refractive index of the media.

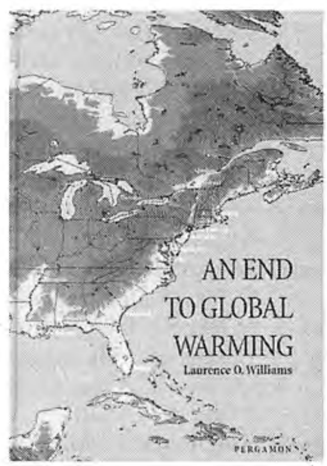
Global Warming: More Hot Air

by Howard Hayden

The Discovery of Global Warming
by Spencer R. Weart
Cambridge: Harvard University Press, 2003
Hardcover, 91 pp., $24.95

An End to Global Warming
by Laurence O. Williams
New York: Pergamon Press (Elsevier Science), 2002
Hardcover, 209 pp., $78.00





Thermometers at the surface of the Earth, sometimes correctly placed in clean, standardized white, louvered boxes with good air circulation, somewhat more than a meter above ground, measure the ambient air temperature. They do so where there are people to read the thermometers. A small fraction of the globe is accurately measured by such thermometers, and there is little reason to conclude that the readings are actually representative of the Earth's average temperature. Moreover, year-to-year changes in the thus-averaged temperature may or may not reflect year-to-year changes in the average temperature of the entire Earth.

Microwave Sounding Units (MSUs) in weather satellites measure temperature remotely, but do so for the entire Earth's surface, giving equal weight to every square kilometer. The record spans a relatively short time—since 1979.

Whatever the relative qualities of the two types of measurements, they do not agree on the recent temperature history of the Earth. The National Academy of Sciences investigated the problem, and could find no fault with the satellite data or interpretation. Moreover, the MSU data are in close agreement with data from weather balloons.

That much said, let us take a look at these two recent books about global warming. It is hard to take any book on global warming seriously, if it does not even mention the disparity between satellite data and the surface temperature record. Neither of these two books makes any reference to the satellite or the balloon data. If they can't even identify the controversy, they can't offer any insight into the controversy. Each book, however, does have something to offer, even if the current situation is not included.

From History to Polemics

Spencer Weart is a historian of physics at the American Institute of Physics. His book is about the history of the idea of global warming, including interesting data about Milankovitch cycles (cyclical variation in the solar irradiance as a result of regular periodic changes in the Earth's orbital inclination and distance from the Sun). First, these cycles were interesting, then they were pooh-poohed, because they did not explain the (then-believed) four ice ages in the history of the Earth. When ice-core data revealed many climatic oscillations, the Milankovitch cycles began to agree far better.

About halfway through the book, Weart's presentation changes from a dispassionate history of science into a polemic, arguing that global warming is a human-caused reality, and implying that everybody who says otherwise is a shill of the coal and oil industries.

To give some idea of Weart's bias, note that there is no mention of weather satellites, or of weather balloons. Global warming promoter Stephen Schneider has precisely ten index entries, versus only one for S. Fred Singer, the first head of the U.S. Weather Satellite Service. Weart does not mention that the Executive Summary of the Intergovernmental Panel on Climate Control (IPCC) bears little resemblance to the actual findings of IPCC's scientists, nor does he mention that most participants were not scientists at all. He makes no mention of global warming advocate Ben Santer's famous rewriting of the Executive Summary.

Weart shows what has come to be known as Mann's "hockey stick graph" showing a nearly constant temperature for the last millennium, but rising dramatically in the last century. He says not a whit about data from hundreds of papers of historical temperature proxies that argue to the contrary. One should expect better from a serious historian of science.

Since Weart's book was published, Canadian scientists Stephen McIntyre and Ross McKitrick discovered that Mann's underlying data had been "manhandled"; their re-analysis yields the result that the 20th Century was not the warmest in the past 1,000 years. Also S. Baliunas and W. Soon at Harvard-Smithsonian, have compiled the data on temperature proxies and showed that, contrary to Mann's assertions, the climate has varied widely during the last millennium.

On his website (http://www.aip.org/history/climate/20ctrend.htm, reference 47), Weart makes the following claim, which is simultaneously false and irrelevant: "In debates during 2001-2003, after the period covered by these essays, this conclusion came under attack by a few scientists. Nearly all other experts found the criticism groundless, based on grossly improper statistical methods."

Weart's claim is false, because no poll was ever taken. It is irrelevant, because science is decided by experimental facts, not by consensus.

Weart mentions Carl Sagan's prediction that so-called "nuclear winter" would follow a nuclear war. He does not mention that Sagan predicted, in a debate on "Nightline" with Fred Singer, that the Earth would turn into an ice ball after Saddam Hussein set fire to oil wells as his troops were driven from Kuwait.

It is difficult to attribute such omissions to mere ignorance.

A Lack of Understanding

Williams's understanding of the controversies about global warming is no better than Weart's. He has the obligatory doomsday chapter about global warming, complete with silly statements like: "Plants will not be able to take advantage of the extra carbon dioxide." "The weather has been unusual for the last 5 to 10 years." "If it [the ice at the poles] all melted it would raise sea level by 80 to 120 meters."

(The amount of snow and ice in glaciers, in fact, is determined by the balance of processes that bring snow, and those that remove it. For example, the loss of glacial ice on Mount Kilimanjaro is the result of a decrease in snowfall, not a change in temperature. The South Pole is rising because of increasing snowfall, not because of a decrease in temperature.)

"Large-scale solar energy collectors will change the albedo of the Earth, which is the amount of radiant energy the Earth adsorbs [sic] or reflects," he writes. "So Arizona will become cooler and the rest of the country will become warmer." (Albedo is the fraction of incident sunlight that is reflected, not the amount of radiation that is absorbed.)

"Solar photovoltaic collectors will require little mechanical maintenance but will require some method of regular cleaning." (Hmm.)

As a book of science, Williams's book is far better than Weart's. After the first chapter, he proceeds to discuss how to handle the "problem." He is, after all, an analytical chemist with numerous inventions to his credit.

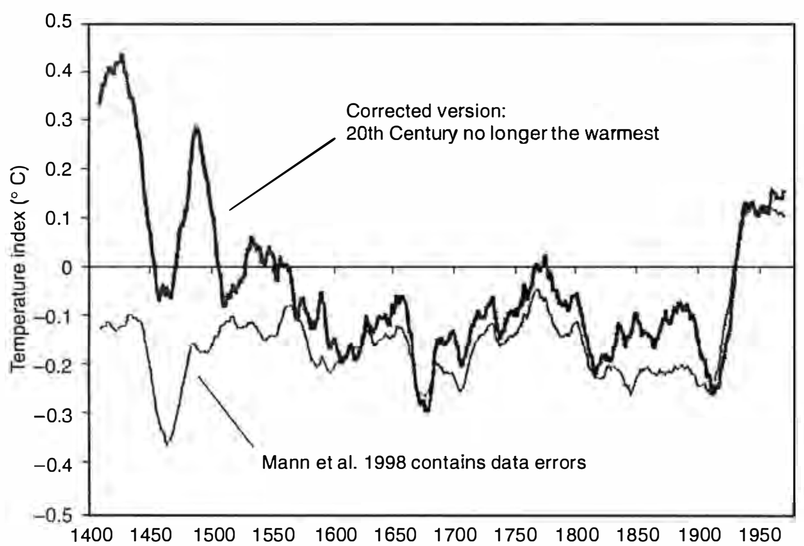
The 'Solutions' That Won't Work

Williams methodologically and carefully shows that the standard solutions to global warming won't work. He shows that the Kyoto Protocol would be about as effective as a Band-Aid on cancer. In enough detail to be convincing, he shows that the answer does not lie in solar power, biomass, hydropower, geothermal power, solar satellites, tidal power, wave power, solar/thermal/electric power, wind, ocean thermal energy conversion, or any combination thereof.

Williams concludes that the only option is to use thermonuclear fusion to generate electricity, and to use electrolysis to produce hydrogen, which will serve as an energy carrier. In that sense, his book conveys ideas that have been around for at least 50 years. He does a very creditable job in his presentation.

But Williams is very naive about radioactivity in nuclear fusion machines. Every fusion device being investigated intends to fuse deuterium and tritium in a vacuum system to produce helium, which is not radioactive. However, the neutron flux would be extremely intense, and there is nothing in the vacuum system to keep the neutrons from hitting the walls, where they will transmute nuclei to radioactive species. One visit to a fusion lab just after a run is completed should disabuse him of his delusion.

What does Williams say about nuclear fission? He claims that breeder technology could last civilization a few hundred years, which is admittedly a very short time on the scale of human civilization. But there is a flaw, an unfortunately common one, in his argument. There are various estimates around about the amount of uranium in the Earth's crust. If we extract only the 1 percent of the energy that comes from U-235, the uranium will last for (choose a number) 50 years. If we extract the energy available in the U-238 (through the



THE SO-CALLED 'HOCKEY STICK' TEMPERATURE CURVE AND ITS CORRECTED VERSION

The thin line is the "hockey stick" curve, allegedly showing recent temperatures (the handle of the stick is at right) as the highest since 1400. Authors of the curve, M.E. Mann et al., claimed that "temperatures in the latter half of the 20th Century were unprecedented," and that the 1990s was "likely the warmest decade." The IPCC adopted the Mann et al. analysis, calling 1998 the "warmest year" of the millennium.

The bold line is the corrected curve, which is derived from the same data set, showing the 20th Century temperatures to be colder than those of the 15th Century.

Source: Adapted from S. McIntyre and R. McKitrick, 2003. "Corrections to the Mann et al (1998) Proxy Data Base and Northern Hemispheric Average Temperature Series," *Energy & Environment*, Vol. 14, No. 6, pp. 751-771.

breeding process), we get 100 times as much energy. By simple arithmetic (but flawed reasoning), the uranium should last for 5,000 years, far more than Williams suggests.

At a price of $300 per Troy ounce of gold, I would lose money filtering through the soil in my back yard in quest of microscopic amounts of gold. If the price were 100 times as high—$30,000 per Troy ounce—the trace amounts of gold in the soil would possibly pay for the mining work. In many places, the payoff would be tremendous.

The situation is no different with uranium. If we can use all of the energy in the uranium, rather than only 1 percent, the uranium in the ground has an inherent worth that is 100 times greater. That is, we could afford to mine uranium that is 100 times less concentrated. It's pointless to do so at the present time, because uranium is readily available, and actually pretty cheap.

In the future, when the highly concentrated uranium is used up, society can use ores that are not as concentrated. As it happens, there is about 300 times as much uranium worldwide at only 10-times lower concentration as there is at the now-mined concentration. And there is yet another factor of 300 in quantity for the next lowering of concentration by a factor of 10.

The upshot is that the factor of 100 in energy retrieval begets *two* factors of 300 in quantity of uranium. That is, the amount of energy we can get out of uranium through breeder technology is multiplied by 100, then by 300, and again by 300, for a factor of about 9 million. Multiply that number by the 50 (again, choose your number) years that we would get from U-235 alone. During the next half-billion years, perhaps society can learn how to use the more abundant thorium as a nuclear fuel.

Even though Williams seems to have gotten his information about global warming from the unenlightened press, his subsequent arguments are largely beyond reproach. He does a masterly job of demolishing the Kyoto Protocol, and of showing why renewable energy sources will utterly fail. The disagreement I have with him lies with his faith in nuclear fusion and his too-easy dismissal of nuclear fission.

Howard Hayden, Ph.D., is the publisher of The Energy Advocate *newsletter (P.O. Box 7595, Pueblo West, CO 81007), and is the author of* The Solar Fraud.

You Can Build a Better-Than-Commercial Telescope!

by Charles Hughes

Making Your Own Telescope
by Allyn J. Thompson
Mineola, N.Y.: Dover Publications, 2003
(reprint from 1947)
Paperback, 211 pp., $14.95

This is a reprinting of a book which first appeared in 1947, and which has been out of print for many years. Although it is more than 50 years old, it is nevertheless a very important book on a subject about which few books have been written. Thompson based his book on his experience conducting classes and a workshop in New York City at the Hayden Planetarium, in the 1940s.

By following Thompson's instructions, *anyone* can produce an optical instrument as good as, or even better than, a telescope purchased from a commercial shop, using only the most basic hand work and tools. I will discuss what you need and the general steps it takes to build the telescope, with the aim of convincing readers to buy this book and make your own telescope.

Photos courtesy of Charles Hughes

The author with his six-inch, short-focus telescope, which has a mirror made with the Thompson polishing method.

Note that a six-inch telescope made by Thompson, and similar to the instruments produced in his Planetarium classes, is still in the possession of the Sky Publishing Company (publisher of *Sky and Telescope* magazine), and is reputed to be optically perfect.

As this book deals only with making a reflecting telescope, the main thing involved is construction of the mirror, which concentrates light from a distant object (stars). The other type of telescope is called a refracting telescope, and it uses glass lenses to concentrate the light to form a magnified image of the distant object. Refracting instruments are very difficult to build, so that most amateurs build reflectors with a concave mirror, at least until they have mastered optical science.

What You Will Need

That the reader has no previous experience with telescope building is assumed here. What's needed (besides enthusiasm) is a glass disk known as a mirror blank, onto one side of which the worker will grind a concavity with another piece of glass called the tool. Both discs of glass are of a thickness of about one inch. Also needed are abrasive powders, polishing compounds, and optical pitch.[1]

One first completes the mirror, which will be six inches in diameter, and then the rest of the instrument: a tube to hold the optical parts, and a stand to direct and support the tube.

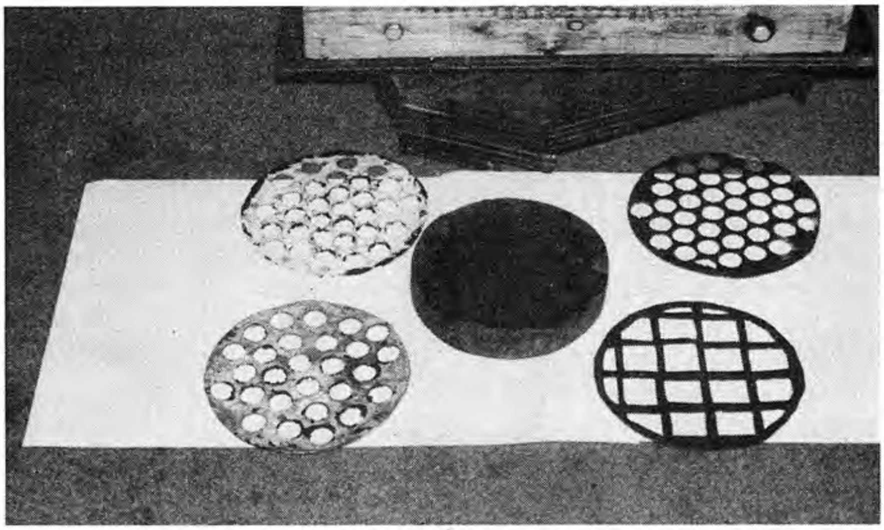
The depth of the concavity of the mirror will determine the focal length of the mirror. Thompson directs the worker to produce a mirror of focal length f/8; that is, a focal length eight times the diameter of the mirror. This length will produce a telescope of moderate power, with a tube length not overly long.

As for technique, the book describes how the amateur works by hand with the two discs of glass, the mirror and the tool, with the tool on the bottom and the mirror on the top, pushing each over the other, with center-over-center strokes, and constantly rotating the work so as to grind out a very shallow concavity evenly ground in the mirror.

On the bottom, the tool will tend to become convex. In effect, what the worker is doing by circular action on both discs, is producing a section of a sphere on both; one concave (the mirror) and the other convex (the tool). The agent of action between the two discs is a charge of silicon carbide abrasive powder, which is harder than the glass substance of the mirror and tool.

The Work Involved

I'll describe in general detail now, how the mirror-making process proceeds, and also some errors to avoid (from my own experience). No machinery is needed to complete a mirror, but some care is needed in finding a suitable workplace to make the mirror; for example, a cellar where the temperature remains constant, and where the air is clean and dust free. For many, however, the only workplace available is a kitchen or bedroom.



Thompson-designed rubber molds for pitch polishing. The object in the center is a finished button type polisher on a plywood base.

Because you need a table to perform the grinding of the mirror on the tool, and where the tool can be secured, the best work bench is a barrel or a steel drum, so you can walk around the barrel as you grind, ensuring even work on all parts of the concavity. If this is not possible, you may work on a kitchen table, being careful to rotate the work as you grind. The tool can be secured by three wooden cleats around the edge.

Start with a teaspoon of the roughest abrasive, perhaps number 60 silicon carbide, put on top of the tool with a few drops of water to form a thick paste. The mirror is pushed back and forth over the tool, center over center, all the while walking around the barrel or rotating the tool and the mirror to ensure even cutting of the abrasive on the glass.

The abrasive becomes worn out in a few minutes and must be washed off, along with the glass residue. This should be done by dipping the discs in a bucket of water and wiping them with a sponge. (Don't ever flush the spent carbide down sink or toilet, or it will badly stop it up.)

A small concavity will form in the face of the mirror, after about an hour. This process is repeated with about eight more abrasives of decreasing size, for about an hour for each grade, until the mirror is finely ground. Simple tests are performed to test the depth of the concavity. Such tests include laying a ruler across the top of the mirror and measuring the space between the center of the mirror and the bottom of the ruler. Using this distance (which should be nearly a fraction of an inch) in an arithmetical formula, will give the focal length of the rough-ground curve.

In the absence of a feeler gauge, the worker can use a dime, sheets of paper of known thickness, or even drill bits to accurately calculate this distance, known as the sagitta of the curve.

Testing and Polishing

A test using sunlight is performed when the mirror is very finely ground. The surface of the mirror is wet with water, and sunlight is directed at a wall until the smallest bright image of the Sun is perceived. The distance from this spot back to the mirror face is the focal length, which should measure about 48 inches for a 6-inch diameter mirror of a focal ratio of f/8.

After about six to ten hours of grinding, going through all the grades of abrasives in the mirror kit, the surface is silky smooth, such that, if the mirror is placed on top of a newspaper, the print may be read through the mirror. Now the mirror is ready to be polished. This operation is one that proves very difficult for most amateurs.

Polishing involves a definite phase change of the mirror surface. An optical polish can be produced only by working the glass surface of the mirror with the tool from the previous grinding phase. The tool is covered with a soft, yielding material, which allows the polishing agent, usually iron oxide, or cerium

The author (left) with a 10-inch long focus telescope, whose mirror he made before he came across the Thompson method.

oxide and water, to work.

For optical work that does not require as much precision as our telescope mirror, such as spectacle lenses, felt or paper polishing pads are used. For the telescope mirror, in order to obtain a fine optical surface, accurate to one ten-millionth of an inch, without holes or bumps on the surface, demands the use of a glass tool covered with optical pitch. This is the biggest problem for the amateur, and the greatest discouragement in mirror making.

Tricky Pitch

Thompson describes in detail how to make the tricky pitch lap. It has been said that pitch, a substance derived from pine tree sap, is the most evil material on Earth. It smells bad, is very flammable, will ruin any clothing it comes in contact with, and, when it is cut, it breaks up and flies all over.

Like glass, pitch is a supercooled liquid. Even though rock hard, it slowly flows, so that when employed on the surface of the polishing tool, it changes shape to conform to the glass curve as glass is removed, and thus always remains in perfect contact. No other known substance will do this.

The conventional way to make the pitch lap is to melt the pitch on a hot plate and pour it on the tool, which has been previously soaked in hot water to prevent its breaking from the heat of the molten pitch. The pitch is coated on the tool to a depth of a quarter-inch and allowed to cool until of gummy consistency. Then the mirror is placed over the pitch and pressed down to assume the shape of the mirror curve.

The pitch is allowed to harden, and then channels must be cut in the pitch surface in a checkerboard pattern, to facilitate the flow of the pitch as it heats as a result of friction during polishing. The channels close in a few hours and must be recut, a really messy job.

Thompson eliminates much of this mess with a molded pitch lap made with a rubber matrix, which the worker can make himself from sheet rubber. This rubber mold is Thompson's own invention, which I followed in making a pitch lap to polish a 6-inch perforated mirror for construction of a short compound telescope. When the lap is finished, it has round buttons on the surface, which do not need trimming during the entire polishing job.

To make the mold, one takes a rubber bath mat, cuts out a disc of rubber the size of one's mirror, and punches a pattern of holes of about 3/8-inch diameter on the surface of the disc in the pattern shown in the book. (See photo, p. 55.) The mirror is then coated with a slurry of polishing rouge (iron oxide) and water; the mold is placed on the mirror, and pitch is poured over the mold. The tool is placed on top of the pitch and pressed down until the pitch gets nearly hard; then it is pulled off.

The pitch will now be attached to the tool, and there will be small buttons of pitch covering the tool. To complete polishing the mirror, the tool is placed down on the work table, charged with polishing compound in water, and the mirror pushed back and forth over the tool in half-hour time periods, until no pits from grinding remain. This may take from 7 to 10 hours of *continuous* work.

After the mirror is polished out, the next and final phase of work to complete the job, is testing the curve and correcting the shape of it, if need be. Throughout the process of grinding and polishing carefully, the mirror will tend to assume a spherical shape, as a result of working with circular strokes. However, in order to focus light from an infinite point to a sharp focus, only a *parabolic* curve will do the job.

In a mirror of f/8 focal ratio, the curve must thus be slightly deformed from a sphere to a parabola. This is accomplished by deepening the center of the sphere, an operation called figuring. If the focal ratio is made much longer than that suggested by the author—say f/10 or f/15—then the images produced will be larger, and the curve need not be parabolized, but can be left spherical. However, the length of the tube then becomes difficult to manage, and you might need a ladder to reach the eyepiece of the instrument!

Thompson also describes the construction of test instruments, such as the Foucault tester which will show the shape of the curve on your mirror, and surface defects magnified 100,000 times. In addition, the author explains the basic laws of optical lenses and mirrors.

I strongly recommend that readers not only purchase this book, but build their own telescopes!

Notes

1. You may buy telescope-making kits, which contain a mirror blank and tool blank, plus the necessary pitch and abrasives, for about $50 for a six-inch telescope. Look in ***Sky and Telescope*** magazine or on the internet for suppliers.

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BOOKS REVIEWED

SPACE REPORT

Mars Was Once 'Drenched' in Water!

by Marsha Freeman

At a special briefing at NASA headquarters in Washington on March 2, scientists who have been poring over the data from the two rovers on Mars, made the categorical statement that there was once liquid water at the *Opportunity* landing site. The Meridiani Planum was "drenched" in water, at some time in the past, stated the science team leader Dr. Steve Squyres.

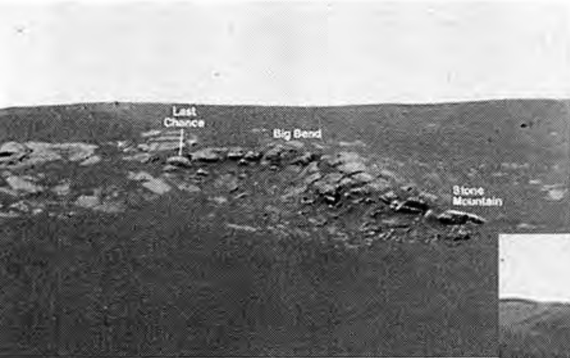
Virtually from the moment the *Opportunity* rover began its geologic exploration on January 25, 2004, there were hints in the panoramic photographs that water was part of the history of this region of the planet—but they were not the hints the scientists were expecting.

Meridiani Planum had been chosen for *Opportunity's* landing site because from orbit, the Thermal Emission Spectrometer aboard the Mars Odyssey spacecraft had revealed the presence there of gray hematite, a mineral that forms in the presence of water on Earth. The rover did not land on the relatively flat, hematite-laden part of the Oklahoma-sized plain, however, but inside one of a number of a small craters that dot the landscape.

The crater is about 72 feet in diameter, and nearly 10 feet deep. Only tens of feet away from the lander, at the rim of this crater, sits a field of rocks that scientists immediately identified as an outcrop of ancient bedrock. Without the rover even having to dig under the soil, some of Mars's history was just sitting

NASA/JPL/Cornell

The rover uses a suite of instruments located at the end of its robotic arm, which is seen here extended over the rocks. The dotted circles highlight shallow holes drilled into the Guadalupe (top) and McKittrick (bottom) rocks by the Rock Abrasion Tool. The instruments were then able to peer inside the rocks to discover their chemical and mineralogical composition.



NASA/JPL/Cornell

The Mars rover Opportunity *has been exploring an outcrop of rocks near the rim of the small crater in which it landed. The inset, below, a detail from the high-resolution panorama, shows the El Capitán region of the outcrop, where the rover has confirmed that water did once exist on the planet Mars.*

NASA/JPL/Cornell

there, waiting to be discovered.

Just two days after *Opportunity* opened its panoramic eyes, the cameras snapped photographs of the nearby outcrop that showed layers in the rocks. The mission scientists proposed that the layering could be the result of either successive deposits of volcanic ash, or sediments that could have been laid down by wind-blown dust—or by water.

By its 17th day on Mars, Feb. 10, *Opportunity* had rolled right up to Opportunity Ledge, as the outcrop was named, and it was observed that the thin layers in the the rocks are not always parallel to each other. This discovery added to the evidence that it was *some* kind of flowing motion, and not volcanic deposits, that created these rocks features, perhaps in ebbs and flows.

Chemistry Tells the Tale

It is only natural that the scientists studying the features on Mars rely on what they know about the geology, chemistry, and history of the Earth to try to inform their understanding of Mars.

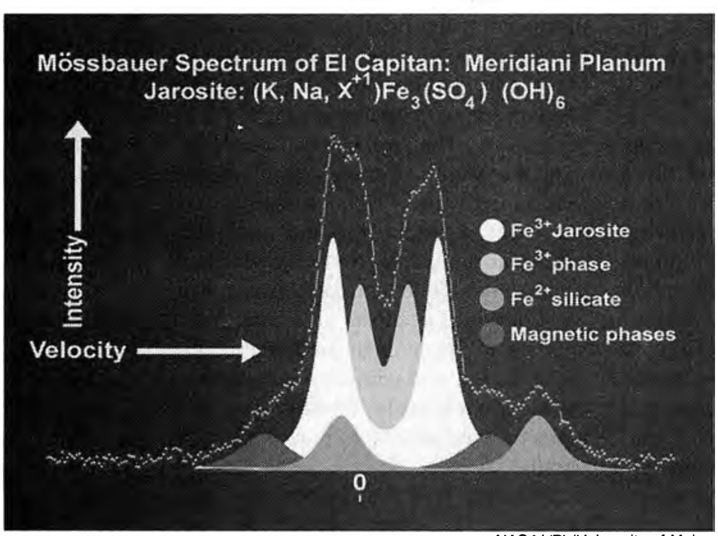
Lyndon H. LaRouche, Jr. has posed the possibility, however, that chemistry on Mars may not be entirely comparable to that on Earth. In a recent article, he discusses the challenge faced by the human race to overcome the limited supply of indispensable minerals natural to Earth that will be increasingly depleted as the population grows:[1]

"We need a physical chemistry which does not continue to rely upon blind faith in 'magic numbers,' to seem to explain away how the Solar System actually generated the repertoire of what is already known as the naturally found periodic table of the Solar System. . . . We must get out of the intellectual prison of our current textbooks, and go to Mars, hoping to find the different physical chemistry which will help us to develop a physical chemistry, including a nuclear physical chemistry, beyond what we know from studies on Earth."

Spirit and *Opportunity* are taking the first steps in this search.

The evidence that convinced the rover mission scientists to make the categorical statement that there was water in the past at Meridiani Planum came from the intensive study of an area of outcropped bedrock at the rim of the small crater in which *Opportunity* landed.

The rover's Alpha Particle X-ray Spectrometer, or APXS, has identified large quantities of sulfur in the rocks of the outcrop. The APXS, which determines the elemental composition of rocks and soils, uses a small amount of curium-244 to generate radiation. It then measures the emission from the object being bombarded by the instrument.



NASA/JPL/University of Mainz

One piece of incontrovertible evidence that the rocks in the outcrop once were soaked in water, was the discovery of the iron sulfate mineral jarosite. On Earth, it forms in an acidic aqueous environment. Here, the key data collected by the Mössbauer spectrometer at the El Capitán rock formation showing the spectral signature of jarosite, the two lightest-colored peaks to the right and left of the graph center.

Related measurements from the rover's Miniature Thermal Emission Spectrometer (Mini-TES) suggested that the sulfur is in the form of sulfate salts, similar to Epsom salt on Earth. Rocks containing large amounts of salts are either formed in water, or are soaked in water over a long period of time after the rocks are formed.

The rover's instruments also found amounts of chlorine and bromine in the rocks at Opportunity Ledge, both of which, in water, become salts.

A third rover instrument, the Mössbauer spectrometer, which can distinguish between varieties of iron-bearing minerals, detected the presence of jarosite—a hydrated iron sulfate—in the same rocks. This mineral on Earth typically spends time in an acidic lake or acidic hot spring environment.

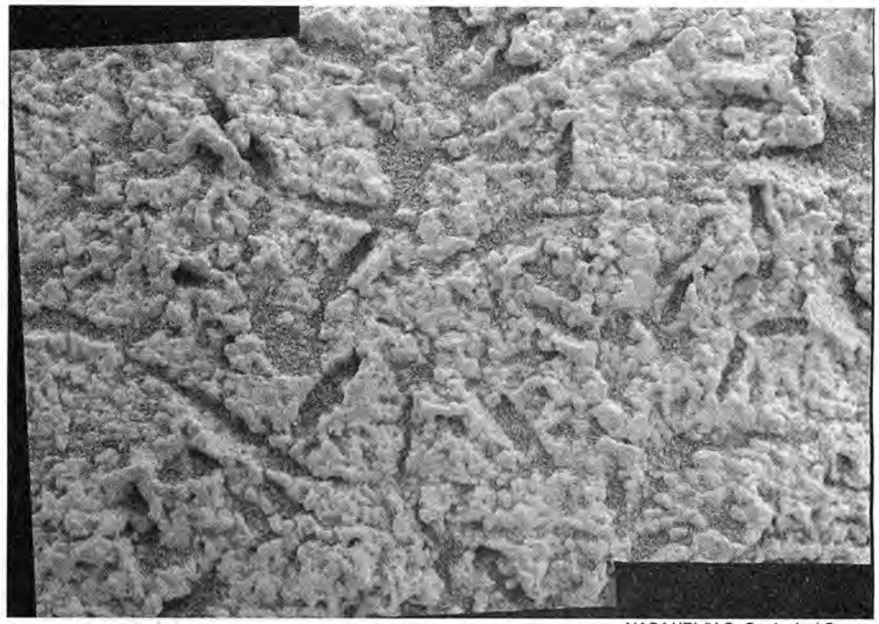
The scientists could find no other explanation for the results of these chemistry experiments, than that water was involved in either the formation, or the later environment, of the outcrop's rocks.

Another piece of evidence for water, presented at the March 2 briefing by Dr. Benton Clark, was the observation via the rover's Microscopic Imager of holes, or voids called "vugs," that are visible inside an outcrop rock. These voids match the distinctive appearance of hollows that form where crystals of salt minerals grow inside rocks that sit in briny water on Earth. Later, when the crystals disappear because of erosion or because water dissolves them, the holes in the rocks remain.

Some of the Mars vugs have disk-like shapes, with wide midpoints and tapered ends. This is consistent with sulfate minerals that crystallize within the rock matrix, either pushing the matrix material aside, or replacing it.

Summing up what the *Opportunity* findings reveal, Dr. Squyres said there are two possibilities that could explain the experimental results: That volcanic eruptions generated layers of ash to create the rocks, and subsurface water then percolated up through pores in the layers; or that there was a salty sea with currents and waves on the site. As the water evaporated, the salt precipitated out, along with other sediments, creating the layered structure and other features seen in the rocks.

Topographical analysis of the Meridiani site does not indicate any basin in the area that could have held the water of an ocean, or evidence of a shoreline, Dr. Squyres observed. But that does not mean, he said, that the site's topography was not quite different in the past.



NASA/JPL/U.S. Geological Survey

When Opportunity's *Microscopic Imager took a close look inside the outcrop rocks, it found these tiny voids, or vugs inside. On Earth, vugs form when minerals in briny water precipitate out, forming crystals inside rocks. When the crystals erode away, or are dissolved and disappear, these hollow areas are left behind. The area in this image is about 1.2 inches across.*

The data that are collected by the rover's suite of scientific instruments take days to collect, and days to transmit back to Earth. Integrating the spectrometer measurements can take up to 12 hours each, at each target site. But long before the detailed chemical analysis presented at the briefing was complete, there had been hints of past water at Meridiani Planum, from the day that *Opportunity* arrived there.

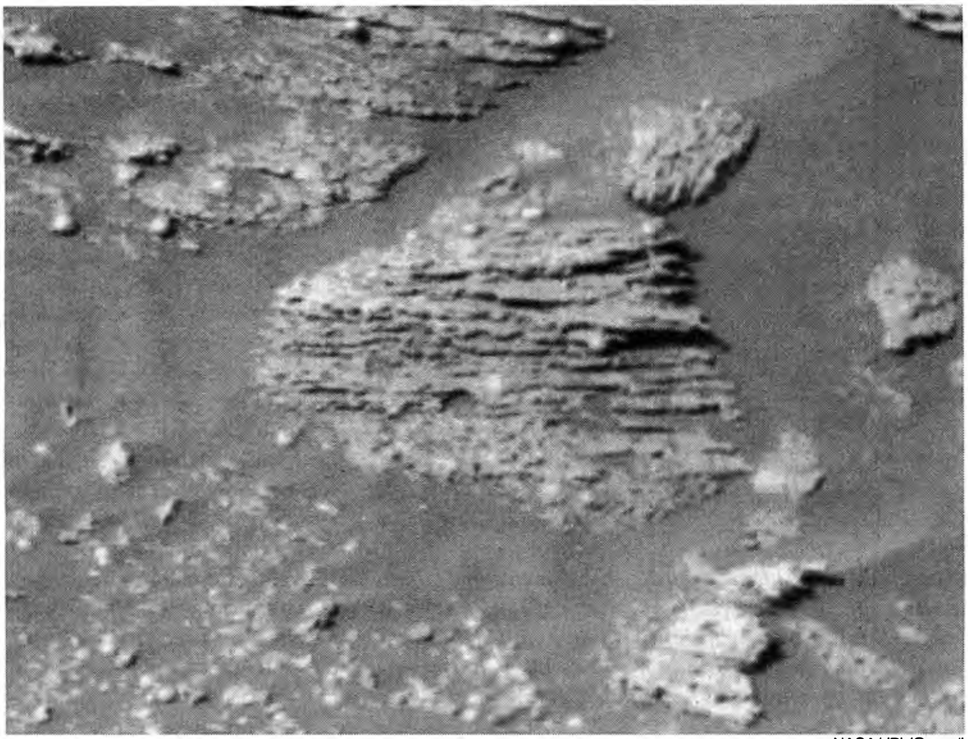
The First Hints

At the March 2 special briefing, Dr. John Grotzinger, a science team member, expressed hope that the upcoming examination of a rock called Last Chance near one end of the outcrop, will provide a closer look at what appears to be a cross bedding in the rock's layers, and will allow scientists to decide conclusively whether volcanic gases or wind or water created the non-parallel layers.

A second hint that water may have once rested or flowed through the crater region came when the rover's Microscopic Imager set its sights on a patch of soil near the landing site, returning images on Feb. 4. The tiny instrument examined a patch only 1.2 inches across, and was able to resolve remarkably circular grains, or spherules, as small as 0.12 inch in diameter, or the size of a sunflower seed. These coarser round grains were sprinkled over a fine layer of sand.

The scientists proposed three hypotheses as to how such tiny rounded objects could be created on Mars: (1) that droplets of volcanic material, spewed out during an eruption, cooled in mid-air and dropped from the sky; (2) that an impact from a meteor or comet tossed material from the ground up into the air, also then raining down into the crater; or (3) that small grains of materials dissolved in water, precipitated out, and became nucleation points for the growth of spheres, in a process described as concretion. From the data then at hand, it was impossible to rule out any hypothesis.

Then, on its 15th day on Mars, or Feb. 9, *Opportunity* sent back its first photographs taken with the Microscopic Imager on one of the outcropped rocks. The rock, Robert E, had spherules embed-



NASA/JPL/Cornell

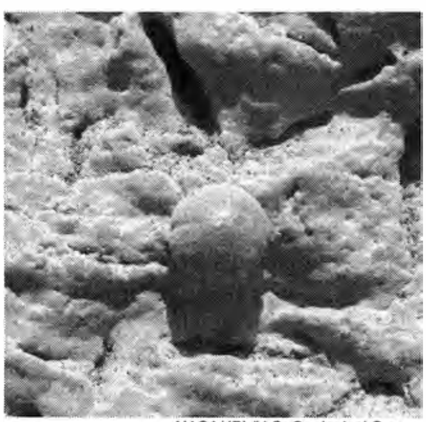
Even from a distance, panoramic images revealed that the outcrop rocks are made up of layers. The panoramic cameras on board Opportunity *took this close-up photograph on Feb. 10. The image reveals that the layers that make up the rock are not always parallel, leading to the possibility that they were laid down through the flowing motion of either wind or water.*

ded inside, with some protruding from the formation, and some seemingly ready to drop off. Here was one possibility as to how the spherules ended up in the soil.

Ten days later, another piece was added to the puzzle. *Opportunity* had used its wheels to dig a small trench in a patch of soil, which was chosen because thermal emission measurements had indicated it was an area where gray hematite could be found. The ubiquitous spherules showed up again, embedded in the wall of the trench.

On Feb. 25, scientists began receiving images and data from the first incision *Opportunity* made into one of the outcrop rocks. The Rock Abrasion Tool (RAT) had sliced into the surface of a rock named McKittrick, grinding a hole about 0.16 inch deep and 1.8 inches in diameter. Inside the interior of the rock were spherules. Unexpectedly, two of them had been cut in half, and one had been scratched by the RAT's diamond grinding wheel, promising to reveal more details.

On March 2, at the special briefing, the scientists announced that they have concluded that the spherules are, indeed, concretions that were formed in water. Their evidence is the fact that these tiny round particles did not deform the rock layers in which they reside, indicating they did not hit the rocks from outside. Also, their presence throughout the rock's interior indicate that they did not fall down from the sky, but formed inside the rocks.



NASA/JPL/U.S. Geological Survey

The ubiqitious spherules are one of the most interesting features at the Opportunity *site. Early in the mission they were found on the soil, and here one is visible sitting in a rock. Their actual size is indicated by the fact that this entire image is 0.6 inch across.*

As the story at Meridiani Planum was becoming more and more interesting, the *Spirit* rover—more than 6,000 miles away from *Opportunity,* on the other side of Mars—was sending back its own intriguing indications that water was present there.

Spirit Makes Tracks

The *Spirit* rover is working inside a very large crater, the size of Connecticut, named after the 19th Century Russian astronomer Matvei Gusev. This site was chosen for the rover's landing because orbital photographs suggest that Gusev Crater was once filled with water, as it has outflow channels and what appear to be beachheads.

As *Spirit* was first on the scene, landing on Jan. 3, three weeks before *Opportunity,* it returned the first *in situ* data on the characteristics of Martian soil, soon after it rolled off its lander. Just as the Apollo astronauts left their footprints on the Moon, *Spirit* left its wheel tracks on the Martian soil.

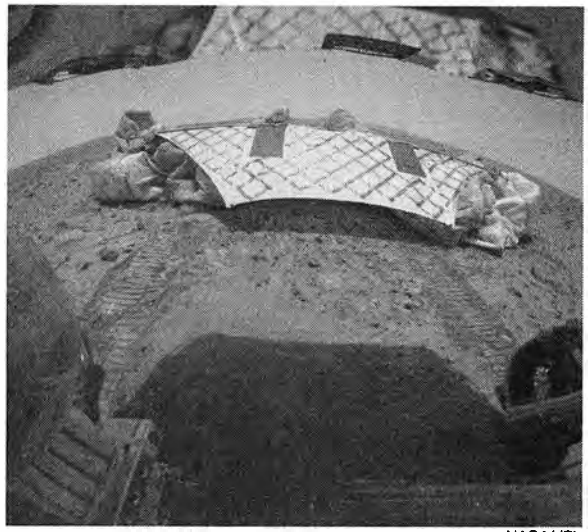
Navigation engineers, responsible for safely guiding the rover around its terrain, noticed from the first post-drive images that the soil seemed to be sticking to the rover's wheels. It is possible, scientists believe, that this cohesion in the soil could be from layers of dust that have been compacted, or that a brine, or salty water, has created a kind of cement.

At a briefing at the Jet Propulsion Laboratory on March 5, scientists discussed another hint from *Spirit*'s adventures, that small amounts of water had existed at Gusev Crater. The interior of a dark volcanic rock named Humphrey, which was examined after the rover's Rock Abrasion Tool had scraped away the surface, contains bright material in cracks and crevices that looks like minerals crystallized out of water. This was reported by Dr. Ray Arvidson.

"If we found this rock on Earth," he

explained, "we would say it is a volcanic rock that had a little fluid moving through it." The amount of water suggested by Humphrey's crystals is far less than that indicated in the mineral structures found by *Opportunity,* but it could be a hint of more extensive findings, soon to come.

As Dr. Squyres is fond of saying, the two Mars rovers came with a "90-day warranty." They may very well continue to be able to collect data for far longer than that, and the science team hopes to still be at the Jet Propulsion Laboratory in the summer. But even if they expire when their warranty runs out, in mid-spring, the rovers have already answered the primary question they were sent to Mars to investigate: Yes, there was once water on Mars.



NASA/JPL

The Spirit *rover made its first contact with the Martian soil when it rolled off its lander on Jan. 15. This photograph, taken with* Spirit's *black-and-white rear hazard identification camera, shows both the rover's tracks and the empty lander, which is about 3 feet away.*

A Roadmap for the Future

Water is the "elixir of life." There is nowhere on Earth that life exists without its presence, and there is virtually nowhere that liquid water exists on Earth where life is not found. This includes even the most hostile environments on Earth, similar to Mars. Even if there is no sunlight or air, if there is water, there is life.

Did life thrive at Meridiani Planum at some time in the past? The Mars Exploration Rover mission will not be able to answer that question; it is not designed to. Dr. Squyres stressed at the March 2 briefing that even just to know when water existed on Mars, for how long, how much of it there was, and where, will require a quantum jump in exploration strategy and technology, to bring samples of Martian soil and rock back to Earth. NASA is considering such a mission for launch in the middle of the next decade. But Dr. Squyres stated without hesitation that at one time, this site "was a habitable place."

Over the remaining weeks, and perhaps months, of their geology mission, the rovers will be able to shed more light on these questions, and also provide scientists with a roadmap of where the most productive sites on Mars may be to target for more intensive investigations in the future.

Notes

1. Lyndon H. LaRouche, Jr., "On the Subject of

Editorial

Continued from page 3

it's part of the universe. And we don't know the universe, until we can find a little bit better answer on what the Crab Nebula is. How could a supernova produce an effect like this? It's the one we know, of this type. We're interested in these fast-rotating binary star systems. How do they function? They produce some very interesting effects—we don't understand them. But, it's part of the universe. People talk about "black holes." Well, I don't believe in "black holes" as black holes. But, there's something acting there. What is it?

So therefore, we have to know, because it's part of the universe. And anything that's significant in the universe, we have to know.

And the same thing, as everything else. The human mind, for example. The behavior of the human mind. All kinds of things.

We don't know—we don't have a definition of life. We have a definition of non-life, which we use to define life. The *phenomenon of life,* we know. You can tell the difference, if something is dead, or not dead. But, what is life? As a *principle,* as opposed to an abiotic process. We are, on the one hand, we are animal bodies. But, we have a characteristic, which no animal has: cognition. Cognition is not a part of animal life. It's outside animal life. Therefore, what is cognition? It's not something secreted by an animal, that is generated by an animal. What generates it?

The Universe Is Cognitive

Obviously, the universe is cognitive. The universe is cognitive. And, under certain conditions, a form of apparent animal life, becomes engaged with a characteristic of the universe, which is called cognition. We don't know much about that. We know the effects. We know the proofs that that's the case. But, the idea of cognition, which I've done a good deal of work on—*people don't even think that, as a subject.* Life is not treated as a subject. You have people faking, and saying, "Well, life evolved" from something or other. From matchsticks, or whatever. Or something rubbing against something. And, man evolved from monkeys rubbing against monkeys, or something.

No. We don't know. And therefore, there are many things we don't know. And therefore, it's important to us, to structure our activities, as a human species, with experiment, exploration, and so forth, to find circumstances under which we can discover *answers,* to questions to which we presently don't have the answers. Like, what does it mean, to have a universe, in which a phenomenon like the Crab Nebula operates? Because that's a characteristic of the universe, that it does operate in the universe. Now, what does that say about a universe?

So, I mean, it's a drive. You're human. You live it once; it's a fairly short life, as the universe goes. What're you going to do with your life? You're going to do something which adds to the stock of human achievement, and knowledge, so that, you make that a profession. That's what I'm doing. You do it.

And you feel happy about it.

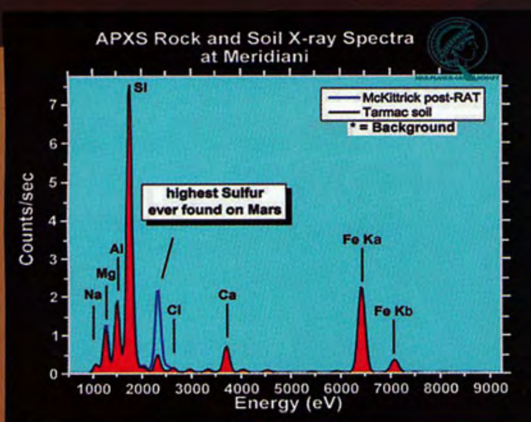
Notes

1. See Lyndon H. LaRouche, Jr., " 'The Woman on Mars,' " in *21st Century* Winter 1996-1997; or on www.larouchepub.com.

TAKING A LOOK AT MARS

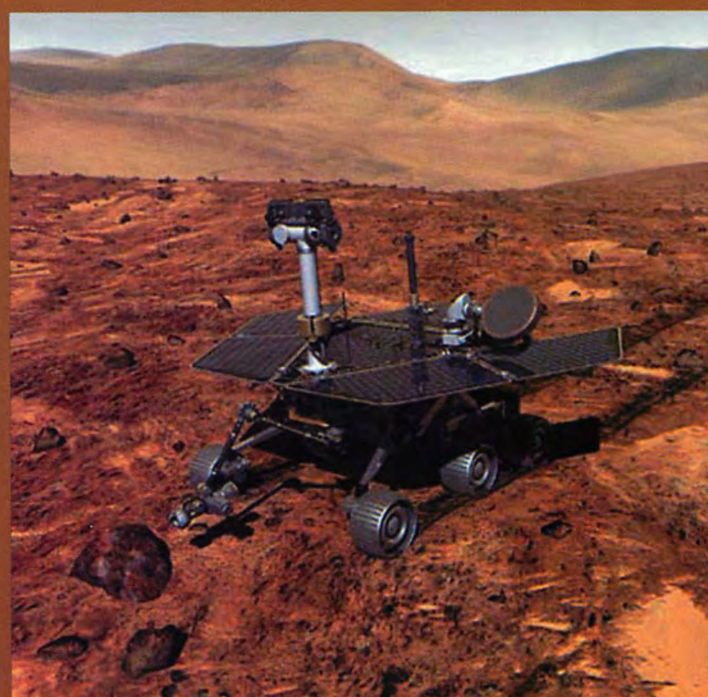
NASA

The El Capitán region is highlighted, in this Mars vista provided by the rover *Opportunity*.



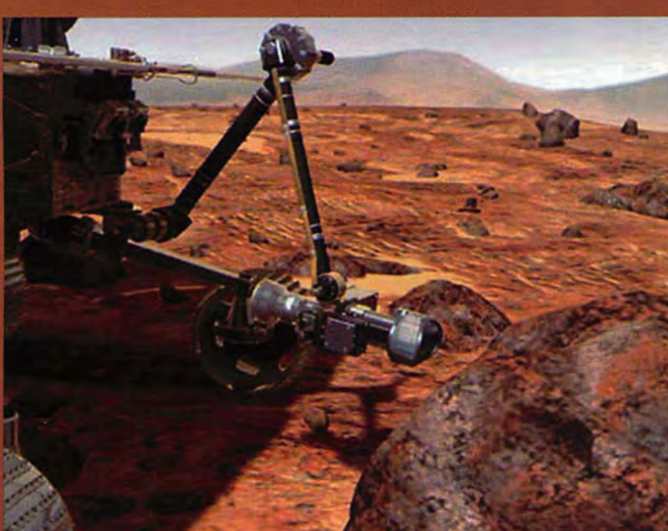
NASA/JPL/Cornell/Max Planck Institute

Inside the rock named McKittrick: After examination of the surface of McKittrick, the Rock Abrasion Tool drilled a shallow hole. Inside, scientists found the highest concentration of sulfur ever found on Mars, along with smaller amounts of chlorine (Cl), another salt mineral.



NASA

The Mars Exploration Rovers are the most complex robotic systems ever sent off our planet. Standing 5-feet tall, the rovers have panoramic cameras on the top of their mast, which provide a 20-20 view of their surroundings. Solar panels supply the power for the instruments, and keep them warm at night. This artist's illustration shows the Instrument Deployment Device at the end of the rover's extended robotic arm, ready to investigate a rock.



NASA

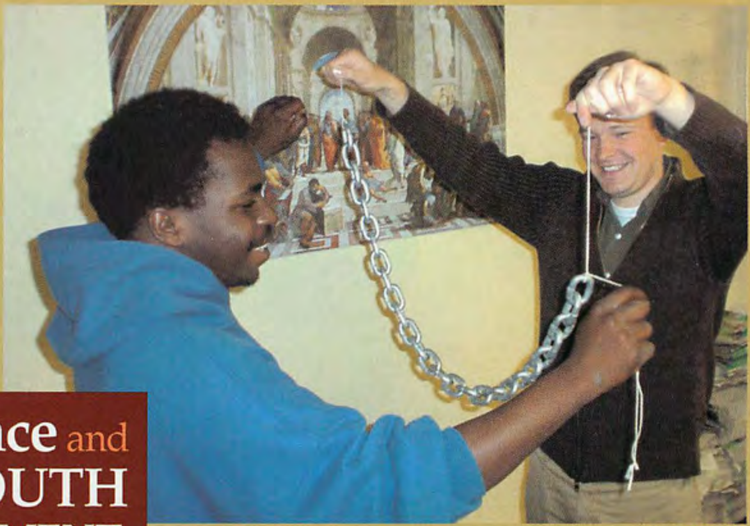
Here, an artist's illustration shows the rover's arm, which has placed the Instrument Deployment Device close to a rock, ready for work. The "hand" contains a Mössbauer spectrometer, an Alpha Particle X-Ray Spectrometer, a Microscopic Imager, and a Rock Abrasion Tool. The arm has a shoulder joint for gross movements, and an elbow, which swings the assembly in to place for each target.

In This Issue

THE LAROUCHE YOUTH MOVEMENT IN COMBAT AGAINST EMPIRICISM

From two different perspectives, LaRouche Youth Movement leaders Jason Ross and Randy Kim take on the problem of empiricism that permeates today's culture, especially in academia. Ross explores some fundamental paradoxes—such as Bernoulli's curve of quickest descent—and Kim looks at the dynamics of the Monge Brigades. Both describe the process of recruiting thousands of new youth leaders.

Science and the YOUTH MOVEMENT

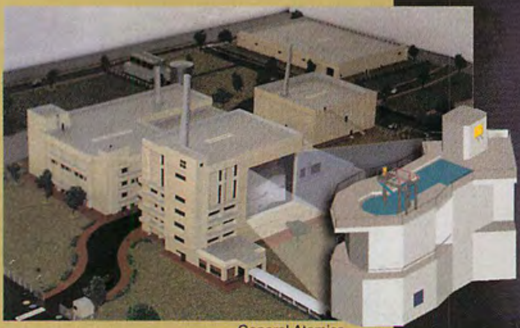


Sylvia Spaniolo

Jason Ross (right) and Jonathan Stuart having fun with a catenary chain.

General Atomics

Looking into the core of a pulsing TRIGA reactor, which can reach higher power levels than the steady-state design.



General Atomics

Artist's depiction of the Thailand Nuclear Research Center. The 10-MW TRIGA multipurpose reactor is highlighted at right.

TRIGA: THE SUCCESS STORY OF A NUCLEAR REACTOR APPROACHING 50

Imagine a small, totally safe nuclear reactor, which went from idea to operation in a little over two years! This is the TRIGA research reactor, designed for training engineers and scientists, and for producing nuclear isotopes. Conceived by Edward Teller in 1956, today, there are 65 Triga reactors, in 24 countries, on 5 continents. General Atomics' Douglas M. Fouquet, Junaid Razvi, and William L. Whittemore tell the story.