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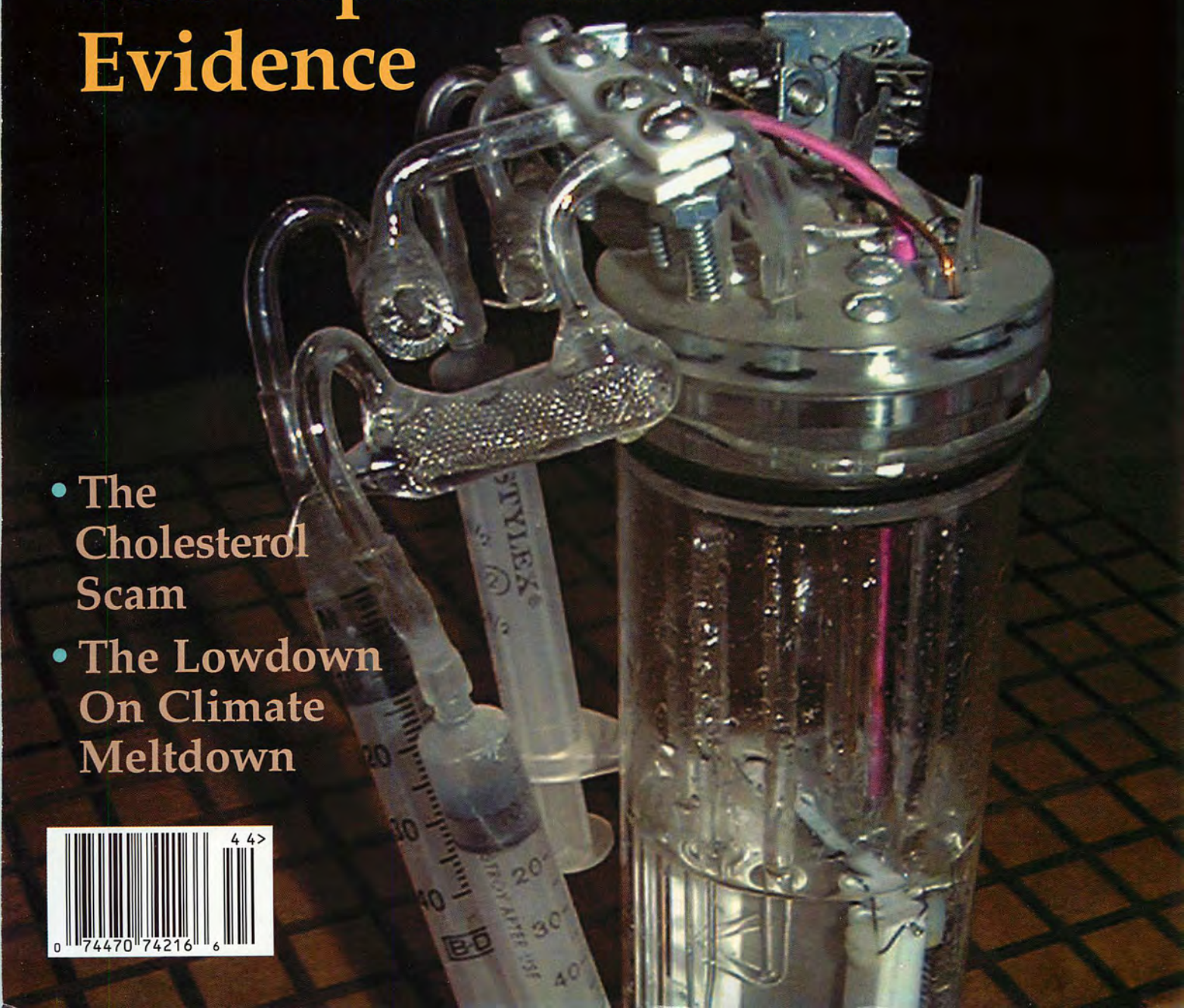

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21st CENTURY SCIENCE & TECHNOLOGY

Vol. 17, No. 4 Winter 2004-2005

Science & The LaRouche Youth Movement

Features

On the Cover: Cold fusion cell; photo by Edmund Storms. Cover design by Alan Yue.

News

Departments

Dan Sturman

A 1960s lathe boring out a cylindrical shape inside a metal block—one of the secrets discovered at Ohio State University. *See page 10.*

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Cold Fusion, The Science

Serious thinkers will pay close attention to the achievements of Yasuhiro Iwamura and his colleagues at the Mitsubishi Advanced Technology Research Center, in identifying the transmutation of individual elements at room temperature in a gas-charged cold fusion cell.[1]

The crucial importance of cold fusion research has always been the potential it holds for fundamental breakthroughs in science. Practical applications, even one so necessary as a new supply of cheap, clean energy, have always been the issue of secondary import.

The Iwamura work implies a revolution in our understanding of the nucleus and its transformations. However, problems in our intellectual culture, affecting both the courageous few who have pursued cold fusion work as well as the mob which opposes them, are holding back that revolution. We turn to that problem shortly. First, both as an aid to the general reader, and to locate the significance of the Iwamura findings, we offer a brief review of the subject of nuclear transmutation.

The transmutation of elements was first detected in the early years of the 20th Century as a natural process in the radioactive decay of uranium, thorium, and radium. It took several years before the phenomenon, which challenged the long-held tenet of the immutability of matter, became generally accepted by physicists and chemists.

Artificial transmutation was first observed, but not proven, in Ernest Rutherford's Manchester, England laboratory in 1914. On introducing a sample of radium C′, a natural emitter of alpha particles, into a container of nitrogen gas, scintillations were observed on a zinc sulfide screen, indicating that a proton was being released. The alpha particle, an emission observed in the radioactive decay of certain elements, had earlier been determined to be the nucleus of a helium atom, possessing

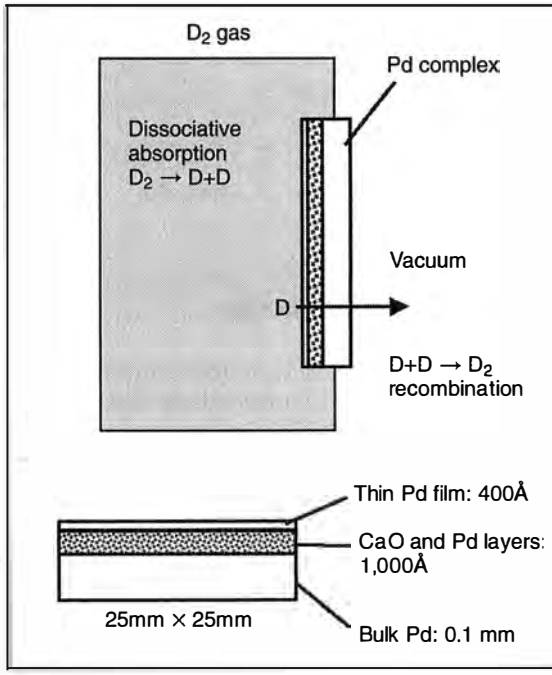


Figure 1
A SCHEMATIC OF THE IWAMURA CELL
Deuterium gas under pressure passes through a thin film of the element to be transmuted, which is coated on the sandwich of palladium and calcium oxide indicated as "Pd complex" in the schematic. The detail shows the "sandwich."

Source: Iwamura, Y., M. Sakano, and T. Itoh, "Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation," *Jpn. J. Appl. Phys.* A, 2002, Vol. 41, p. 4642.

two protons and two neutrons.

Later, in the 1920s, it was concluded that the proton earlier observed in the nitrogen gas was the result of a transmutation, produced when an alpha particle collided with the nitrogen nucleus, yielding oxygen-17 and releasing a proton. Soon, the transmutations of other light elements were accomplished by similar means. By the late 1920s, it had become possible to achieve transmutations by accelerating hydrogen nuclei (single protons) in the powerful electric field of such devices as the van de Graaf and Cockcroft-Walton generators, the predecessors of modern particle accelerators.

The Difference

The distinction between these earlier means of bringing about transmutation, and those reported by Iwamaura, et al., is this. In both the case of the natural decay of an alpha particle (which travels at speeds up to one-tenth the velocity of light), and the artificially accelerated charged particle, enormous work is being exerted to accomplish the transmutation.

That is not the case in the recently observed transmutations, which are brought about with very little exertion. To accomplish the fusion of deuterium by previously known methods requires temperatures of millions of degrees. The mass defect of the most common products shows that an energy of about 3 to 4 MeV (million electron volts) had been produced per fusion. In the transmutations observed by Iwamura, an energy per fusion of 50 to 67 MeV is achieved, at approximately room temperatures with little expenditure of energy.

Using a sophisticated detection apparatus, as Dr. Edmund Storms reviews the case in our cover story this issue, Iwamura's team observed the transmutation by deuterons of thin layers of the elements strontium, cesium, and barium which had been coated onto a sandwich of palladium and calcium oxide. The transmutations observed were:

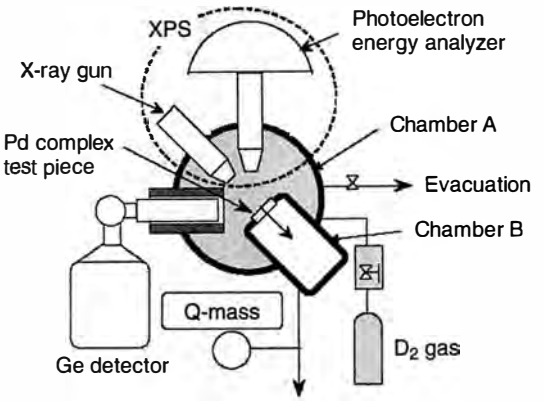
$$4D + {}_{55}Cs^{133} \longrightarrow {}_{59}Pr^{141}$$
$$4D + {}_{38}Sr^{88} \longrightarrow {}_{42}Mo^{96}$$
$$6D + {}_{56}Sr^{138} \longrightarrow {}_{62}Sm^{151}$$

The isotopic distributions of the new, transmuted elements matched those of the original element (although these are far from the natural distributions for the transmuted element) lending credence to the conclusion that a true transmutation is being observed, and not the concentration of a previously present impurity.

Figure 2
IWAMURA DETECTION APPARATUS

A schematic of the detection apparatus for real time observation of the transmutation in Iwamura's cold fusion cell.

Source: Iwamura, Y., M. Sakano, and T. Itoh, "Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation," *Jpn. J. Appl. Phys.* A, 2002, Vol. 41, p. 4642.



The implications for science of these results are wonderfully exciting. Just as the first discoveries of transmutation at the beginning of the 20th Century gave birth to nuclear science, we have now the hope that an understanding of this new process occurring in a cold fusion cell will lead us to a deeper understanding of the nucleus, the chemical bond, and much more that is as yet unimagined.

The Problem in Science

As the Storms article reviews, dedicated individuals and small groups of scientists from around the world have shown great courage and personal integrity in pursuing the trail of cold fusion. This, despite the vicious and continuing smear campaign which began within a few months after Drs. Martin Fleischmann and Stanley Pons announced their results on March 23, 1989.

The principal weakness of most of the work we have seen, both in cold fusion and in some other areas where the accepted paradigm is being challenged, has been the failure to come to grips with the axiomatic errors dominating modern scientific thinking. What is in fact a systemic error is too often viewed as a mere aberration.

The cold facts are these. The teaching and practice of science today is dominated by a cult, a high priesthood obsessively committed to a radical form of empiricist reductionism. By that, we mean a denial of the effective existence in the universe of ideas. All actions are to be explained by the motions of presumed elementary particles, and the *a priori* statistical laws supposed to be governing their behavior. Among the leading forms of expression of the disease are a utopian's belief in the efficacy of blackboard mathematics, and a persistent falsification of the history of science, in which the real act of discovery (and often the name of the discoverer himself) is replaced by a textbook formalism. The latter is akin to a dictionary nominalism respecting the ideas contained in words.

Remedying the effects of that miseducation, and the continuing social pressures to which nearly all of us are subjected, has been the principal ongoing commitment of this journal.

Respecting the first expression of the priesthood's ideology, the 1799 polemic of Carl Friedrich Gauss against the obsessive errors of Euler, d'Alembert, and Lagrange on the subject of the Fundamental Theorem of Algebra, is much to the point.[2] We have had some things to say on this matter and the broader topics correlative to it in past issues, and will be saying more.

Here, we devote ourselves to that second expression of the problem, wherein the gloved hand of the scientific mafia reaches into realms relevant to the pursuit of cold fusion.

'Worse than Cold Fusion. . .'

In 1990, in the course of contacting leading figures in nuclear science about the breakthrough in cold fusion, my colleague Charles B. Stevens had a memorable phone call with the prominent nuclear physicist Hans Bethe, whom Stevens had known for over a decade. In the course of the discussion, Stevens told

National Academy of Sciences

William Draper Harkins, the originator of nuclear science in the United States.

Dr. Bethe of his recent historical researches into the work of William Draper Harkins, the distinguished head of the University of Chicago Physical Chemistry Department, during the pre-World War II decades. Harkins had originated nuclear research in the United States in the years before World War I, and had been the teacher and colleague of our colleague and teacher, Dr. Robert J. Moon.

No sooner had Stevens mentioned the name of Harkins, than Bethe interjected: "The only thing worse than cold fusion, is Harkins."

Knowing that there would not have been a Manhattan Project, nor a nuclear science in the United States, without Harkins and his students, I coined the term "Bethe decay." Yet this was no recent event. As I discovered upon deeper research, it had had a long half-life.

Bethe's telephone outburst made clearer to me an idea which had already been germinating in my mind from comparing the stories told me by the first-hand participant Moon, to what I had read in the textbook accounts of the history and development of nuclear science. To put it plainly, there was the stink of fraud. Subsequent research has confirmed and reconfirmed the initial suspicion, with increasing sharpness.

The conclusion was at first frightening. For, once recognizing that the conventional history of the science is false, one soon comes to see that conventionally taught and accepted theory is also riddled with error and assumption. The fear arises in realizing that all that one had previously accepted must be reconsidered—and that at the price of becoming largely an outcast among those one had considered one's teachers and peers.

This is the task which faces all those who persist in cold fusion research. If we are to make advances in the science of cold fusion, the systemic errors within the history of our conceptions in the field must be put on the table. The battle between Bethe and Harkins provides a useful reference point for the re-examination. We share this brief summary of some observations, with that in mind.

For example, the issues raised by the Iwamura results go to the heart of our understanding of the nucleus. Shaking off all the mountain of formalism, in truth our understanding of what goes on when two nuclei collide to form a new one, is painfully scant. Do we wish to rethink the assumptions we bring to the interpretation of this process? Harkins's account of his development of the concept of the intermediate nucleus, and his battles with Rutherford, the Cavendish Laboratory, and Bethe (who insisted the intermediate nucleus was impossible) must be known. Harkins's 1946 account, "The Neutron, the Intermediate of Compound Nucleus, and the Atomic Bomb" (*Science,* Vol. 103, No. 2671, pp. 289-302) is a good place to look.

Or, to take another example. Cold fusion, in most forms we have seen so far, implies a relationship between a crystal lattice or some form of chemical bond, and the nucleus. What do we actually know of that? The early writings of another student of Harkins, Robert Mulliken (like Moon, both an accomplished physical chemist and physicist), shed important light on a re-examination of that subject.[3]

The work of Moon himself, is the most directly relevant. We had devoted our previous (Fall 2004) issue to the subject. Moon began his scientific work from a principled and moral opposition to any form of reductionism. The achievement of nuclear fusion was the central devotion of his work from about the age of 18. From an early period, Moon's work on fusion was guided by his understanding of the flaw in the Maxwell presentation of electrodynamics. No serious scientific discussion with Moon could take place without the subject of the 1870 paper of Wilhelm Weber arising.[4] There, the conditions for the stable aggregation

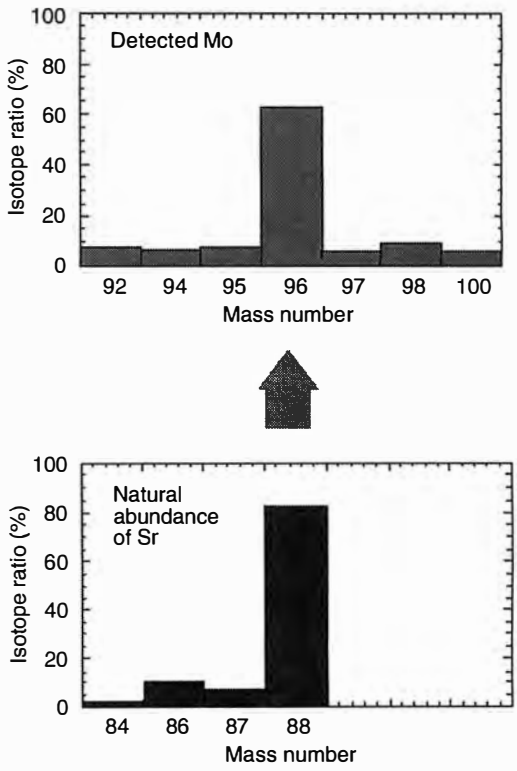


Figure 3
ISOTOPIC RATIO OF TRANSMUTED ELEMENTS

The isotopic ratios of the transmuted element molybdenum (Mo) are quite similar to the ratios of the element transmuted, strontium (Sr), although these ratios are not characteristic of natural molybdenum.

Source: Iwamura, Y., M. Sakano, and T. Itoh, "Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation," *Jpn. J. Appl. Phys. A*, 2002, Vol. 41, p. 4642.

of two like charges were derived from the known law of electrodynamics.

With his 1986 breakthrough in identifying a nested grouping of Platonic solids as the form of symmetry for the nuclear charges, it became apparent to Moon that there would exist certain straight-line paths of entry into the nucleus, free from Coulomb resistance.[5]

Moon had much earlier explored forms of cold fusion in crystalline substances, and had achieved proof-of-principle confirmation in materials including lanthanum hexaboride. He was thus not surprised at the results announced by Fleischmann and Pons in March 1989.

The Promise

Fraud may seem a strong term to describe the situation in modern science. Yet it is scientifically precise. Indeed, it has a long history. The history of science since classical times, is nothing but a battle between two opposing philosophic views. The cultural problem is that university education during the lifetimes of most people alive today has supported the anti-science side of the matter. In the controversies of Plato vs. Aristotle, Kepler vs. Galileo, Leibniz vs. Newton, Gauss vs. Euler, and Riemann vs. Cauchy, modern education has taken the side of reductionism and empiricism in each case. So much so, that for most today, even the chosen method of resolving the controversies is a pragmatic empiricism.[6]

Real science, as opposed to a textbook mastery of the digested bolus of past work, begins with the certainty that there is something wrong with our present view. To find that error of assumption or omission in the framework of presently accepted conceptions, or to discover that new phenomenon which helps light our path to the embedded error, is our passion. This is the true promise of cold fusion research.

—Laurence Hecht

Notes

1. See, Iwamura, Y., M. Sakano, and T. Itoh, "Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation," *Jpn. J. Appl. Phys. A*, 2002, Vol. 41, p. 4642, and Edmund Storms, "An Update of LENR for ICCF-11," pp. 7-8, at www.lenr-canr.org.
2. See Lyndon LaRouche "Visualizing the Complex Domain," *21st Century*, Fall 2003 and at www.21stcenturysciencetech.com for a comprehensive treatment of the problem.
3. Mulliken, who collaborated with the great Göttingen spectroscopist, Friedrich Hund, found himself in early opposition with the Heitler-London and Slater-Pauling conceptions of the chemical bond. Although his work on the molecular orbital concept was belatedly incorporated into the currently accepted smorgasbord, it is the probing analysis and historical approach which make his papers of the early 1930s thought-provoking reading for whoever would try to rethink the present from the standpoint of the future. Blackboard jugglers can wave the quantum equations all they wish. G.N. Lewis's cube (the valence "octet"), remains to be explained, as Mulliken will remind us.
4. Wilhelm Weber, "Electrodynamic Measurements—Sixth Memoir, Relating Specially to the Principle of the Conservation of Energy," *Phil. Mag.*, S.4, Vol. 43, No. 283 (Jan. 1872), pp. 1-20 and 119-149.
5. An examination of the electrodynamic force on a charge entering the nucleus along the line of orientation of what I described as a "Weber pair" (Fall 2004, pp. 58-73) will illustrate the point.
6. For a full historic treatment of the subject in the context of the cold fusion question, see: Lyndon H. LaRouche, Jr., "Cold Fusion: Challenge to U.S. Science Policy," Science Policy Memo (Washington, D.C.: Schiller Institute, August 1992).

Letters

On *A Priorism* in Science

To the Editor:

A question from the Fall 2004 editorial, "Robert J. Moon: Scientist for the 21st Century":

Wow! What a question!

"Is it possible to arrive at a truth concerning man's relationship to the physical universe by means of *a priori* mathematical formalisms, of the sort implied in Euclid's *Elements,* or in the treatment of the so-called imaginary number?

". . . Gauss came down in no uncertain terms against such a proposition. . . . For Gauss, no mathematical truth were possible without a grounding in experiment. . . ."

Could you give more examples of how *a priori* statements and experiment relate to each other?

Let's say a person starts out with a bias for spirit first, morals and ideas second, and material third, similar to a typical religious position. If true, each dimension would tend to have substantial control (*a priori*?) to some degree over the next dimension. How much control?

If an equation or mathematical statement of some kind influences material to some degree, how are the exceptions and reserved areas expressed? Is the square root of –1 involved? Which makes all of "logical reality" a logical impossibility (another, but similar subject)? Perhaps the constants of integration (which can also substantially change the values of equations) in a calculus formula may be involved?

Even when a person believes that theory needs an experimental test, more examples would be appreciated to more readily see what form these combined statements make (*a priori* plus experiment), and how these two interact with each other, which could easily be the subject of a longer article, with many resulting questions, ongoing.

It would also be interesting, on the social-political side, to know more on why some factions are so allegedly determined to promote the "*a priori* only" approach. What are the dynamics going on?

Thank you, and may the Highest Intelligence guide and protect us all.

John Williams
Lakeland, Fla.
john.williams.307@verizon.net

The Editor Replies

That's a stimulating question, and I only regret that we do not have space now for the long answer it deserves.

The best thing I can suggest is you look at Lyndon H. LaRouche's "Visualizing the Complex Domain" in our Fall 2003 issue (also available at www.21stcentury-sciencetech.com. under "Sample Articles").

LaRouche addresses there the relationship among the three domains of abiotic, biotic, and cognitive, proposing a unique solution to the classical "mind-body paradox." His discussion of the intervention of the cognitive into the lesser domains, by means of fundamental scientific discovery realized through the "machine tool principle," should give you some food for thought.

I am not sure that a mathematical equation could influence matter in quite the way you seem to suggest. Read the LaRouche piece, if you will, and let's see if we cannot find a more solid ground for further discussion.

A New System for Mass Dampening

by James Rasmusson

The genesis of this work came from my penchant to observe and analyze simple events. I've long observed how small children (whose legs can't quite reach the ground) can, from a standstill, "pump" a swing up to a creditable height. When I analyzed how this was done, I decided to study this phenomenon in a laboratory setting. As so often happens, a simple inquiry blossomed into a treasure trove of discovery, with applications to stabilizing tall structures and spacecraft. One aspect of my inquiry touched on the Leibnizian discovery of the principle of *vis viva,* recently discussed by Rachel Brown in the Summer 2004 issue ("The Paradox of Motion").

The pendulum model is my laboratory version of the "swing and child" observation. I devised pendulum experiments to explore the influence of a mass being shuttled inside a closed chamber on the end of a pendulum that was free to swing about fixed point(s). It was found that the pendulum could be made to speed up or slow down through the application of shuttling mass sequences. Depending on when the ball is accelerated off the push-plate, there can be constructive or destructive interference. These sequences involve the influence of gravity working in concert with a well-timed kinetic energy exchange within a closed chamber.

The pendulum experiments began with the "Start-up Sequence." It was found that by judiciously timing the successive accelerations and decelerations of a shuttling mass, that a pendulum could begin swinging from a dead stop and eventually achieve a zenith angle of 30 degrees.

The pendulum experiments also produced two methods for dampening the momentum of a swinging pendulum. These methods came to be known as the "Hard Landing Slowdown Sequence" and the "Soft Landing Slowdown Sequence."

The dynamics of a resilient column that is undergoing oscillation is very similar to the dynamics of a swinging pendulum. Column experiments were devised to explore the influence of a mass being shuttled inside a closed chamber that is located at the top end of an oscillating column. It was found that the column could be made to speed up or slow down through the influence of the column's bending force working in concert with a well-timed kinetic energy exchange within a closed chamber, using the same sequences that were used with the pendulum experiments.

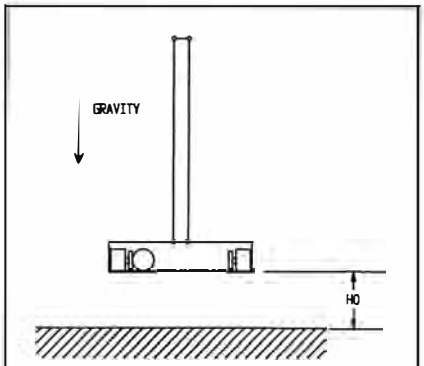
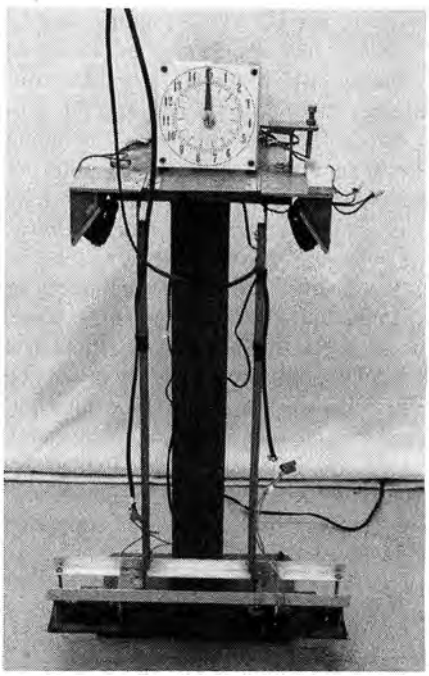


Figure 1
THE PENDULUM MODEL

A practical application that arises from the column experiments is an oscillation dampener for tall structures. The current technology uses massive dampers that weigh hundreds of tons. By contrast, a module using the methods gleaned from the column experiments could deliver the same counteracting force from a device that is considerably less massive. Rather than having an enormous weight that is accelerated very slowly, this module would have a modest weight that undergoes a large acceleration. This is yet another example of the Leibniz *vis viva* or living force phenomenon.

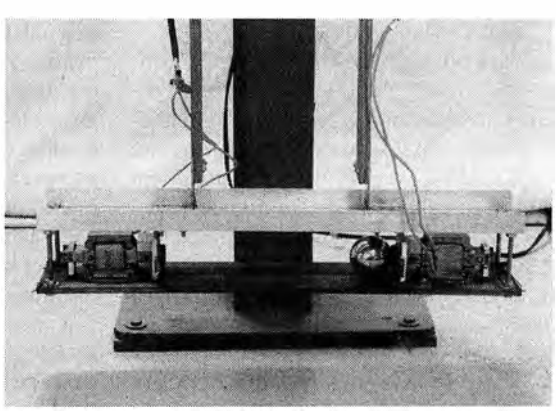
Another practical application involves a dampening system installed in modular space stations.



A *The pendulum model.*

The Pendulum Model

The pendulum model has a rigid tether which is affixed to bearings at the top end and a chamber at the bottom end. The chamber always remains level to the ground. This is accomplished by having a four bar linkage for the tether.



B *The push-plates of the solenoids are magnetized.*

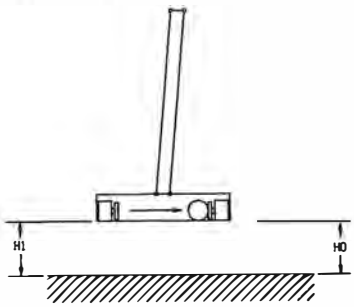


Figure 2
THE SEED PULSE

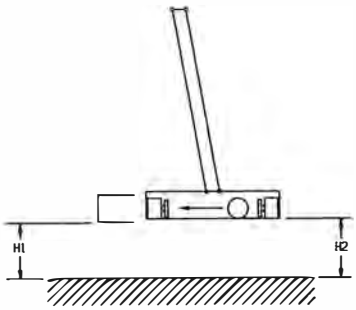
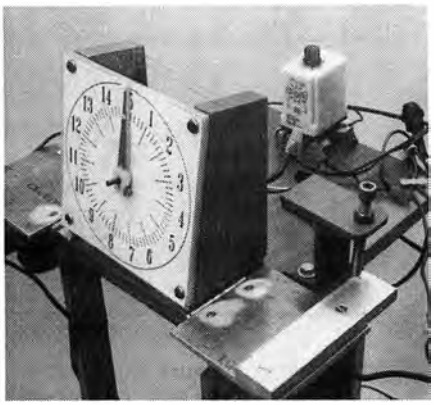


Figure 3
THE SOLENOID IS FIRED



C *The "time off" delay relay.*

(See Figure 1 and Photo A.)

Inside the rectangular chamber, at opposite ends, are solenoids that can be fired and recoiled on command. There is a 2-inch steel ball inside the chamber that is shuttled back and forth along a groove by the action of the two solenoids. The push-plates of the solenoids are magnetized so as to capture and then release the ball at the proper time (Photo B).

For these experiments, the timing of the ball launch was done by the operator, who observed the position of the pendulum. Although this method is not as accurate as an automatic system with sensors and micro-processors, it was accurate enough to prove the validity of the sequences.

The Start-up Sequence

With the start-up sequence, the pendulum begins in an "at rest" condition. The bottom of the chamber has height H_0 off the ground. Because of the influence of gravity, the "at rest" position sees the tether linkage perpendicular to the ground. The ball is positioned at left, magnetically held to the push-plate (Figure 1).

The sequence begins when the left solenoid is fired and the ball is shuttled across the chamber to the push-plate of the right solenoid. This initial pulse can be thought of as a seed pulse (Figure 2). The bottom of the chamber has now achieved an amplitude height of H_1. As the ball hits the right plate, it is held in place by a magnet. The whole system is now swinging. The movement and the amplitude, H_1, is nothing more than the reaction brought on by the center of gravity having been momentarily shifted because of the ball having changed positions.

For building onto the initial pulse, the optimum time to fire the right solenoid is when the pendulum is farthest to the right (the zenith height). In actual practice, there is a window of opportunity for firing the ball off the solenoid for building onto the initial pulse. This is typically when the pendulum is from 0 to 5 degrees away from the zenith height. Firing the solenoid after the pendulum has achieved the zenith height, that is, when it has begun its downward travel, has the effect of cancelling momentum.

The solenoid is fired at the optimum time and the pendulum "climbs" to a greater height, H_2. (Figure 3). The amount of force imparted to the ball has been chosen so as to guarantee that the ball will hit the left plate before the chamber (which is swinging) has reached its leftward zenith.

This sequence can be repeated indefinitely. The kinetic energy and the zenith height will increase until an asymptotic balance is reached.

Soft Landing Slowdown Sequence

In order to know if a given sequence is actually slowing down the pendulum model, we had to first establish a baseline. The baseline was chosen to be the time it takes for the swinging pendulum to go from a zenith angle of 48 degrees to a zenith angle of 44 degrees, as a result of frictional losses. The model had a pair of switches on both sides of the pendulum support, connected to a "time off" delay relay (Photo C). The sweep hand of the timer will continue advancing as long as the pendulum is within the 44- to 48-degree range. Trials indicated that the elapsed time for the pendulum to slow from a zenith angle of 48 degrees to 44 degrees, because of frictional losses, was consistently 9.2 seconds.

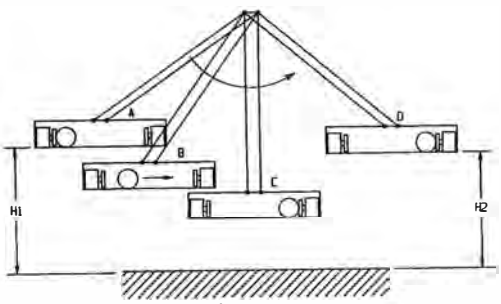


Figure 4
THE SLOWDOWN SEQUENCE

In the slowdown sequences, the pendulum was already swinging with initial amplitude of 48 degrees, denoted as H_1 in Figure 4. We wish to slow down or decrease the amplitude of the pendulum by the influence of a shuttling ball sequence. We'll first examine a left-to-right half cycle. Keep in mind that the pendulum has zero velocity at the ends of its swing path and, because of gravity, maximum velocity at the bottom of its swing path. The swinging pendulum will accelerate from its most leftward point (Point A) to the center (Point C), and will decelerate from the center to its most rightward point (Point D). Figure 4 shows four key events that occur during this sequence.

At Point A, the ball is magnetically

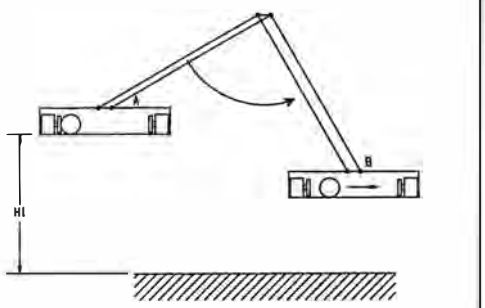


Figure 5
FIRING THE LEFT SOLENOID

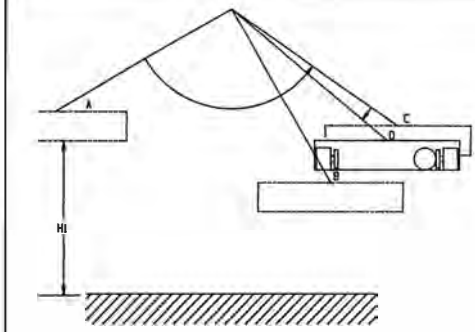


Figure 6
TIME SEQUENCE OF FIGURE 5

held to the push-plate of the left solenoid and the chamber has height H_1.

Starting from Point A the pendulum begins falling, moving to the right. At Point B (a position somewhere along the chamber's downward trajectory) the left solenoid fires, pushing the ball to the right. Because of action/reaction, some of the rightward velocity of the chamber is cancelled. The ball is now moving rightward inside the chamber at a velocity (relative to the ground) faster than that of the chamber. I find it helpful to think of the launched ball as a free body momentarily moving through space at a constant velocity, acting as though it were of a system external to the chamber.

The chamber is under the influence of gravity and will continue accelerating until point C, reclaiming some of the velocity that it just lost when the ball was fired.

We have judiciously chosen the force of the solenoid and the timing of the firing so that, at center Point C, the rightward velocity of both the chamber and the ball will be ostensibly equal. In actual practice, the velocity of the ball must be slightly greater to ensure that it will unite with the right push-plate. Consequently, the ball will have a virtually reactionless touchdown (a soft landing) when it arrives at the push-plate of the right solenoid. The ball is then held onto the right push-plate by the magnet.

The chamber will continue moving to the right, decelerating, because of the influence of gravity. When the chamber reaches the zenith of its rightward travel, point D, it will now be at a height H_2, which is less than the initial height H_1. To continue decreasing the amplitude of the pendulum, the SLSS can be repeated in a like manner on the right-to-left half cycle.

With the pendulum model experiments, the elapsed time for slowing the pendulum from 48 to 44 degrees, using the SLSS, was an average of 4.6 seconds. This is substantially less time than the baseline time of 9.2 seconds. Clearly the SLSS dumps momentum.

The SLSS can be repeated indefinitely with the pendulum dumping momentum with each repetition. However, with the SLSS, each successive pulse has a diminishing return wherein the pendulum can never stop because of the influence of the SLSS.

Hard Landing Slowdown Sequence

Like the soft landing sequence, this is a procedure for diminishing the swing of the pendulum. We again started with the ball held firmly onto the left push-plate with the pendulum at Point A with height H_1. The pendulum begins its downward movement to the right, passing through center Point C and then moving upward toward the right side zenith. At Point B, the left solenoid is fired, pushing the ball to the right (Figure 5). Point B has been chosen to be a position somewhere along the chamber's upward trajectory. Because of action/reaction, some of the rightward momentum of the pendulum is cancelled.

The chamber will reach a rightward height of H_2 which, as a result of the ball having been shuttled at point B, is less than the original height H_1. For clarity, Figure 6 shows the four bar tether as a single center line and previous positions in the sequence as phantom lines. Again, the ball is momentarily floating through space, acting as though it were of a system external to the chamber.

We chose the Point B "firing point" and the acceleration off the push-plate to allow the ball to hit the right push-plate after the pendulum has reached its most rightward position (zenith), and then begins its downward travel to the left. The ball hits the plate of the right solenoid when it is on its downward swing at Point D. There is a "hard land-

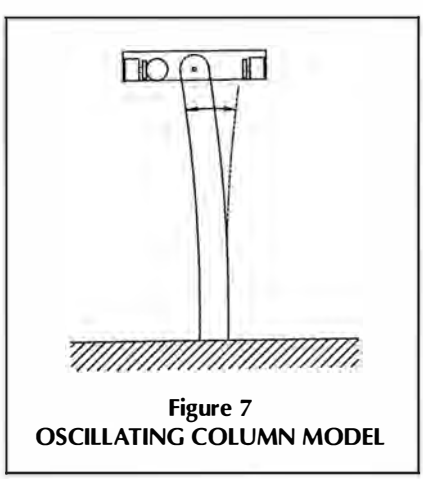
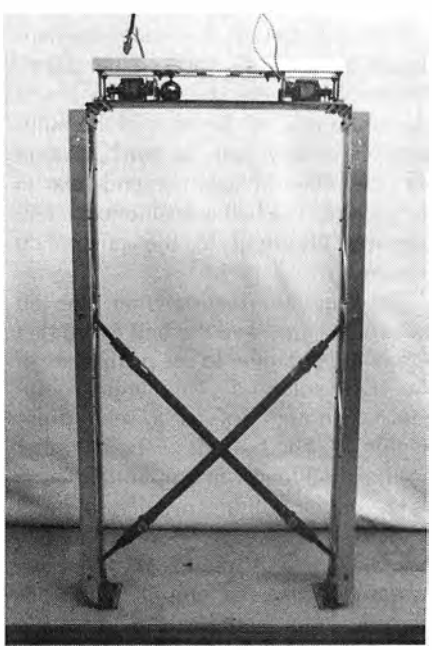


Figure 7
OSCILLATING COLUMN MODEL



D *The oscillating column model.*

ing." When this happens, still more of the momentum is cancelled. The sequence is repeated during the leftward half cycle, and momentum dumping continues.

With the pendulum model experiments, the elapsed time for slowing the pendulum from 48 to 44 degrees, using the HLSS, was an average of 3.2 seconds. This is substantially less time than the baseline time of 9.2 seconds. Clearly the HLSS dumps momentum very efficiently.

With the hard landing sequence, there are two cancelling pulses within a given half cycle and the chamber can be completely stopped through the influence of the HLSS.

The Oscillating Column Model

Dynamically, the oscillating column model is almost identical to the pendulum model. It has the same chamber that can undergo the same startup, soft landing slowdown, and hard landing slowdown sequences.

The oscillating column model has the chamber located at the top end of a resilient column. The principal difference between the oscillating column model and the pendulum model is that the column is accelerated/decelerated not by gravity, but by the recoil force of an elastic column (Figure 7 and Photo D). Note that the model achieves oscillation by having a criss-cross arrangement of extension springs and a four bar linkage construction.

Like the pendulum model, the oscillating column model has zero velocity at the ends of its travel and a maximum velocity at the center point of its travel, as well as having the chamber always remaining parallel to the ground.

Of the three sequences, the HLSS shows the most promise for practical applications.

A Dynamic Dampening Application

One practical application for the method and apparatus gleaned in the column experiments would be as an oscillation dampener for tall structures. This dampener would employ the HLSS. The current technology uses massive dampers that weigh hundreds of tons. By contrast, an HLSS could deliver the same counteracting force from a device that is considerably less massive. Instead of an enormous weight that is accelerated/decelerated very slowly, this module would have a modest weight that undergoes a large acceleration. And unlike the current technology, this module would deliver not two, but four cancelling pulses per cycle. A less massive system would save materials, fabrication time, and space.

A commercial module would be able to automatically attenuate oscillations in any direction, using multiple dampening modules and/or a gimbal ring system. Additionally, the energy that is "dumped" could be converted into a useful form, such as electricity.

A Spacecraft Application

Large orbiting spacecraft are made from hundreds of meters of lightweight composite struts, which are jettisoned into space where they are later assembled. These structures would collapse under their own weight on Earth, but in the microgravity of space, they are relatively rigid. These spacecraft must be re-oriented by an onboard retro rocket/inertial wheel system on a regular basis. These attitude corrections are necessary for many reasons, including the aiming of telemetry equipment. Unfortunately, the re-orientation of these flexible spacecraft tends to produce out-of-control oscillations.

Professor Hughes of the University of Toronto worked on this problem for many years. He expresses the problem as follows: "Large, flexible spacecraft are very hard to control because they can vibrate in several modes or directions, and the correction for one mode can set up vibrations in another. Also, the vibrations are very slow and can continue for a long time . . . the effects of an overcorrection can last an equally long time."

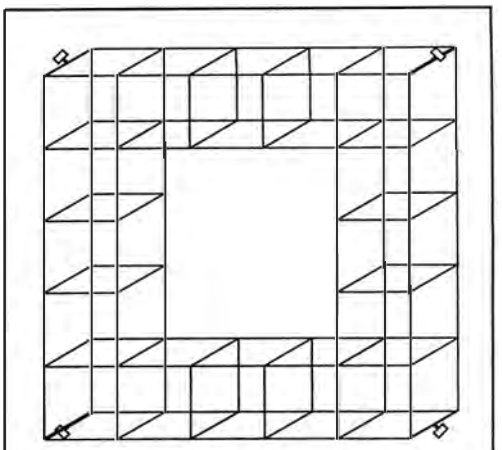
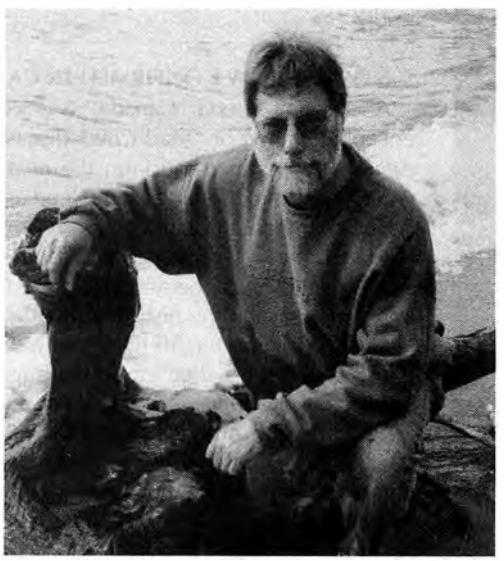


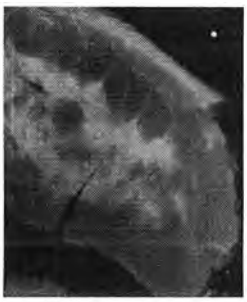
Figure 8
ARRAY OF HARD LANDING SEQUENCE MODELS

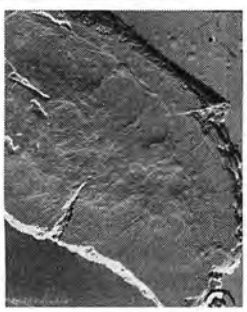
An array of Hard Landing Sequence Modules could be placed as shown in Figure 8.

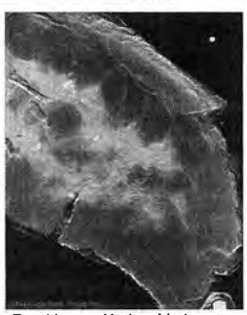
The average retro rocket/inertial wheel attitude control system runs out of rocket propellant after about 10 years, and recharging the propellant tanks is difficult and expensive. Hard Landing Sequence Modules do not utilize propellants; they require electricity, which can be obtained indefinitely from solar panels. This means that the modules don't require servicing to restore propellant stores, thereby saving time and resources.



James Rasmusson, an engineer with a specialty in prosthetics, now heads Retronix, Inc., a product development company. The experiments reported in this article led to patents #6,089,511 and #6,345,789, which cover four distinct embodiments. Only the pendulum and the column embodiment are covered in this brief article. For more information, email author at retronix@wmol.com.







Three images of human breast tissue: Top, a conventional mammogram. Above and at right, images taken using the DEI method, which provide much sharper contrast.

Brookhaven National Laboratory

NEW X-RAY METHOD PROVIDES ADDITIONAL DATA ON SOFT TISSUES

A low-dose X-ray technique that visualizes both bone and soft tissue is being developed at Brookhaven National Laboratory. Called diffraction enhanced imaging (DEI), the technique provides conventional X-ray data, plus information usually provided only by ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI), and other technologies. The DEI image is sharper and more detailed than alternative methods.

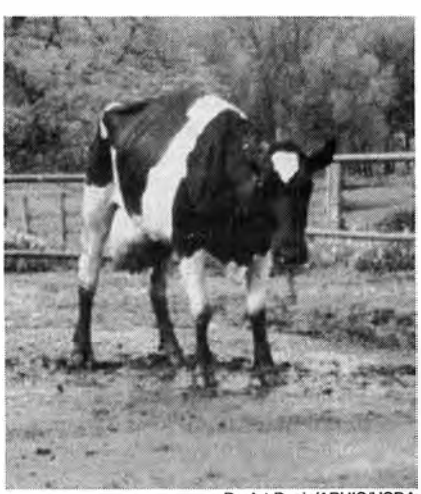
The research project is headed by Dr. Zhong Zhong, and uses X-rays from the National Synchrotron Light Source at Brookhaven. Synchrotron beams are both more intense and more concentrated, and can be tuned to one wavelength. The beams are tuned monochromatically before being beamed at specific tissue. The tissue scatters the beams at different angles, causing the X-rays to refract. Then the scattering and refraction patterns are detected by an analyzer crystal, which diffracts the X-rays according to the scattering angles. The diffracted beam is then transferred to a radiographic plate, which shows the differences in intensity.

In clinical use, DEI is expected to enhance mammography in the search for breast cancer, and other soft tissue pathologies, such as lung cancer and osteoarthritis, as well as problems of skin, ligaments, tendons, and large blood vessels, Zhong said.

THE FUTURE OF RUSSIA IS THREATENED BY EXPLOSION OF HIV/AIDS

A just-released report written by Murray Feshbach of the Woodrow Wilson Center documents that the explosion of HIV/AIDS in Russia threatens the very existence of Russia. The report, underwritten by U.S. Agency for International Development, compared Russian and international statistics, and found that Russia's HIV/AIDS epidemic differs from the disease in North America and Western Europe in terms of age group affected. "In the West . . . some 70 percent of the population afflicted . . . are over 30 years of age. [But] in Russia . . . over 80 percent are under 30 years of age." One example cited is that the number of potential army conscripts testing positive for HIV has increased 25 to 27 times over the last five years.

The lead author, Murray Feshbach, has investigated public health problems of Russia for over a decade. "If the leadership continues to pay only lip service to the issue [of AIDS] . . . then the consequences in the very near term of 2 to 3 years, and certainly a decade from now, will be devastating to the society, to family formation, to the military, to productivity of labor, to continued growth" of the nation, Feshbach said.



Dr. Art Davis/APHIS/USDA

Cattle stricken with BSE, suffer progressive degeneration of the nervous system and eventual death.

NEW BSE COW CONFIRMED IN CANADA, BUT U.S. WANTS OPEN BORDERS

A cow in Alberta, Canada, was confirmed to have BSE (bovine spongiform encephalopathy) or "Mad Cow" disease on Jan. 2. The Canadian Food inspection Agency quarantined the farm the next day, and began a trace-back to determine what other animals ate the same feed as the 10-year-old BSE cow, and where the offspring of the animal have gone. But on Jan. 4, the U.S. Department of Agriculture reiterated that it will reopen U.S. borders to imported Canadian cows on March 7, 2005, regardless of the new BSE case. Congress must approve the USDA's administrative decision in the next two months.

Senator Byron Dorgan (D), from North Dakota, a state which borders Canadian Plains provinces, called for an investigation of the USDA's actions, which, he said, are based on politics, not science. So far, three cases of BSE cows have been confirmed in North America since May 2003; all were around 10 years old, and trace back to Alberta, where, it is charged, tainted feed was in use. Rations fed to cows came from processing companies that had recycled animal waste parts back into the livestock feed chain. This practice was subsequently outlawed in Canada. Technically, the United States also has restrictions on animal waste parts in livestock feed, but there are documented cases that this ban has been ignored.

35,000-YEAR-OLD FLUTE, MADE FROM MAMMOTH TUSK, FOUND IN GERMANY

Archaeologists at the University of Tübingen announced in November 2004, the discovery of a flute made from a woolly mammoth's ivory tusk, found in a mountain cave in southwestern Germany near Ulm. The 18.7-centimeter flute, dated to 35,000 years ago, was pieced together from 31 fragments.

This flute, and two others made from swan bones that were previously found at the same site, are much older than any other musical instruments that have been discovered. The Stone Age flute required sophistication to carve from solid ivory. One of the scientists plans to construct a replica out of mammoth ivory to hear what the flute might have sounded like.

© University of Tuebingen

The most ancient musical instrument found to date.

NASA'S MARS EXPLORATION ROVER MARKS ONE EVENTFUL YEAR ON MARS

Millions of people all over the world have shared, in near-real time, the adventures of the Mars exploration rovers, and marvelled at the most dramatic of the 62,000 pictures they have sent back to Earth since their landing Jan. 3, 2004. The rovers were designed to last 90 days, and drive perhaps a mile. But after one year, they are in "great shape," Jim Erickson, rover project manager, reported Jan. 3, 2005, with *Spirit* boasting nearly 2.5 miles on its odometer.

Spirit has spent the past months climbing up the Columbia Hills, finding ancient bedrock and evidence of past water on Mars. *Opportunity,* after spending months intensely studying bedrock in a small crater, has tackled a much larger one, and is now examining the pieces of its own heat shield, which protected it during entry and then was discarded before touch down.

Mission scientist Steve Squyres reported that the science team is planning out another year's worth of investigative goals for the rovers, although they could suffer any one of a number of equipment failures, at any time. But their lasting legacy, Squyres stated, is the discovery that there once was liquid water on Mars. Now we know, he said, that "Mars once had habitable conditions on its surface."

SOUTH AFRICA CALLS FOR PEBBLE BED REACTOR BUILDING PLAN

South Africa's Minister of Public Enterprises, Alec Erwin, outlined a multi-billion rand infrastructure investment program, including funding for the Pebble Bed Modular Reactor (PBMR), which is planned to come on line by 2012. Beyond this pilot nuclear plant, the plan calls for building 24 commercial PBMR reactors of 165 megawatts each, to boost South Africa's electricity generation. The program also calls for upgrading railway lines and equipment and ports. The plan was reported in South Africa's *Sunday Times,* Oct. 24, with the headline "Get Ready for the Boom, Erwin Warns."

WALTER SIMON, GENERAL ATOMICS NUCLEAR POWER LEADER, DIES AT 67

Walter Simon, a former Senior Vice President and a leader in General Atomics' nuclear power programs for more than 40 years, died in August 2004 of a heart attack at age 67. Mr. Simon was in charge of the company's joint program with Russia to build a high-temperature gas-cooled modular nuclear reactor, the GT-MHR. As a nuclear engineer, Mr. Simon joined GA Europe in 1961, after graduating from Aachen University. Moving to General Atomics headquarters in San Diego in 1964, he participated in both the Peach Bottom and the Fort St. Vrain high-temperature gas-cooled reactors.

An interview with Mr. Simon on the GT-MHR project in Russia, which is designed to burn weapons plutonium, appears in the Spring 2002 *21st Century,* pp. 70-74. As for the United States, "I wouldn't mind having 10, or 15, or 20 [GT-MHRs] under construction at the same time," he told *21st Century.*

Walter Simon: "There is just no way around building these new reactors."

Secret of Lost Civilization Discovered in University Basement

by Dan Sturman

Walking around my parent's house, here in the Imperial Valley, part of the Great California Desert, one has to ask oneself, "Where do all these material goods come from?" Knowing that this area is only good for agriculture, desert recreation, and, well, prisons, how do these everyday goods get produced when that type of industry just doesn't exist anywhere around here?

The reader might be in the same situation as I, maybe with a few different specifics in your surrounding area: "Where does that plastic casing for the telephone come from?" or "How in God's name can we shape all that hard metal into a 1.8 liter, 4-cylinder DOHC engine?" you might be asking yourself.

SCIENCE and the LaRouche Youth Movement

Sometime in late October, when the LaRouche Youth Movement was organizing the forgotten men and women of the once-prosperous state of Ohio (one of the many Rust Bucket states that once were rich from the wealth of the industry I am about to speak of), we were privileged enough to organize on the campus with the largest student population: Ohio State University, in Columbus. Somewhere in that haystack, we found a needle, a very sharp and diamond-edged needle: Ohio State's Manufacturing Processes Laboratory, where the tricks and the trades of production start.

As Lyndon LaRouche mentions often enough, the children of those long-forgotten farmers and steel mill workers no longer want to continue daddy's work. They want to leave the family business for the fast-paced world of sex, money, and power. Once you step into this gargantuan room, you can already feel the need for students. In our entire tour, we encountered maybe four students—and this was during the midday rush at this over-sized circus some people like to call OSU. Although the room may not have been filled with students, it was defiantly filled with tools and machines for them to use.

Photos courtesy of Dan Sturman

Watching a 1960s lathe bore out a cylindrical block are (from left) OSU lab guide, Siri Martin, Dan Makrides, Karen Ehrlichman, and Elizabeth Cisco.

Throughout the tour, we were blessed with an opportunity to see some of the more highly technologically advanced machine tools used in industry today. Many range in cost from $80,000 to well over a few hundred thousand dollars, and are still very flimsy. These modern collages of plastic and aluminum that are formed into machines, are given approximately a 20-year life span, whereas the World War II machine tools, still in use in the shop, are more than half-a-century old and aren't expected to clock out of the productivity business, and into the scrap heap, any time soon.

Now you might be asking yourself, "Where does this university get all this money from?" Are they playing the stock market game, or maybe investing alongside Fannie Mae? Maybe they decided to go along with what California has decided to do to higher education, and raise the tuition? Maybe, but without too much hassle, our tour guides revealed that most of the funding comes from two sources: Either it is given as a gift from a large company that wants research done by the school, or the lab is given a good bargain by the machine tool company.

The Old and the New Machine Tools

Now, as I just mentioned implicitly, there are two types of tools at the lab facility: the modernized machines and the older machines. It's simple to make the distinction. One type has a computer attached to it, with a robot arm possibly somewhere along the line; and the other, well it's much simpler in terms of understanding the processes that go on

when running it.

Now it seemed to me that modern machines can do two different things. One is that they can do things never done before, such as the Nano-Lathe. Just briefly, a lathe is a machine tool that uses circular rotation and a sharp tool to shave off and carve out circular patterns in some type of material. What makes the Nano-Lathe so special, is that it can reliably shave as closely as 1,000,000th of a millimeter! (See photo.)

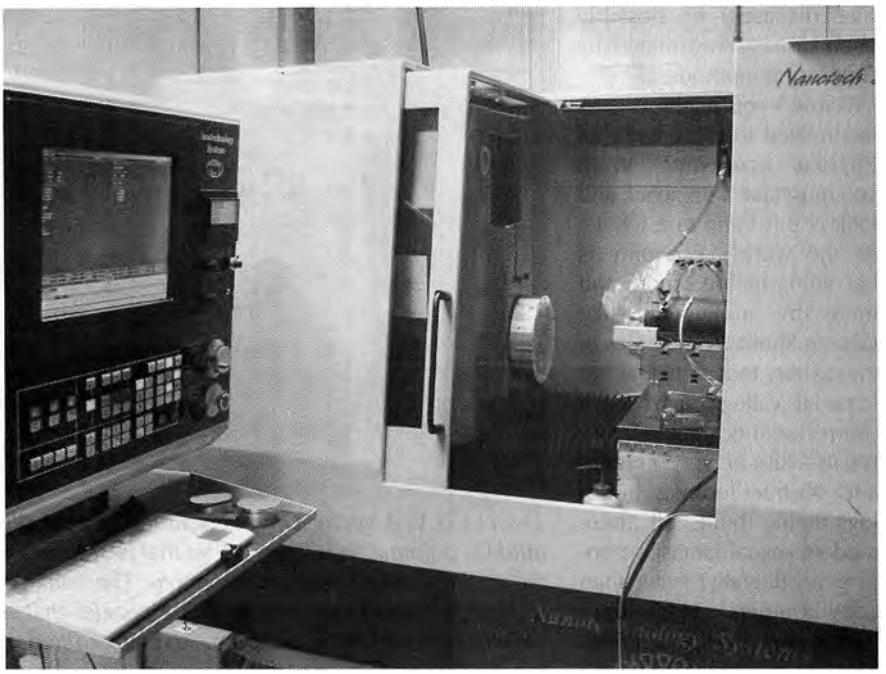
Modern machinery can also complete a tedious task in a much shorter time, such as the Vector Drive electronic milling machine. A milling machine is a tool that cuts out shapes with bits on a flat surface. The rotational action is transferred to the bit at high rpm (revolutions per minute), and that is used to carve out the metal, wood, or other material.(See photo, p. 14.)

The ability of the computer on the Vector Drive to have a layout of the piece being cut, a variety of different bits to use, and to cut precisely, very quickly, allows for greater potential from the worker, because of new free time created by finding more effective means of production.

Knowledge of computer technique is required for all of these modernized machines tools. The laborer in the factory now has to be educated to a higher standard, to be able not only to draw, but to program the drawing and the dimensions, so that the computer can understand it and use that model to create whatever was thought up in the engineer's mind. It's not as simple as just draw and go. Now, that person has to make sure that the program and the machine tool have all parts and bits correctly placed, centered, and in the right slots.

Simple enough? We'll talk simple in a moment, but for now, think about this.

Amazingly, a fair amount of the modern machine tools we saw were made somewhere in the United States, but unfortunately, not all of them, as is the case with all the World War II machine tools. Where has this seemingly lost industry gone? Why wouldn't a young mind want to employ himself or herself in creating the tools and products necessary to ensure that the current population can sustain itself? Maybe there's a lack of creative freedom in the class that would normally inspire someone to dabble in the field of producing goods? I doubt that.



Nanotechnology System's Nano-Lathe. It can shave metal to specifications as close as 1,000,000th of a millimeter.

One of the projects given to the students by the school, was to invent a device that could measure the movements of the spinal cord (see photo).That sounds like something I wouldn't mind tinkering with. How about learning how to use molten steel to make a lovely heart for your significant other? Believe it or not, these things, but not limited to just these, are done in the process of these classes. Why is this tool, this industrial know-how, which dragged us out of the Great Depression, as the heart of production and manufacturing, being jettisoned out of culture today? Is this knowledge not necessary for a functioning society to work?

Economy and Drug Addiction

Something that can be compared to this is the human body, using and addicted to crack cocaine. What you have, essentially, before the drugs are used, is a well-functioning system, created by God, to discover and further organize the universe—something that no other living creature on the planet can do—because there exists a well-tempered system, or relationship of manifolds, between the immortal cognitive soul and the mortal physical body.

A similar relationship is seen in the science of LaRouche's economics. The relationship is such: The cognitive soul is in relation to those minds in the society which discover fundamental breakthroughs in science, music, art, and so on. The physical body stands in direct relation to the work that is employed because of these discoveries.

Now, what happens when the drug is inflicted upon the individual? First, the mind . . . well that's toast. As the individual takes and abuses the drug more and more, he finds himself further and further out of reality. Things such as: the person finding it more necessary to have crack in his system rather than food or water, or finding himself caring less and less about how he appears to the rest of society, because, well, his capability for understanding what society is, or what it is to be human, is currently nowhere to be found.

Physically, things are more apparent: He may get an immediate pleasure, rush, or euphoric feeling, but this does not last long; his physical appearance diminishes as rapidly as his increase in usage; sometimes homelessness or signs of mental instability are obvious. Underneath the skin, his whole mortal infrastructure is collapsing; his heart and lungs, and, for that matter, the rest of his internal organs are being used and abused; and in a period of time, especially if the addiction becomes stronger, the person can die of a multiplicity of different organ failures, other degenera-

tive diseases, or possibly even disease transmitted by drug-using methods.

"How," you might ask, "is this related to the science of Physical Economy?" Well, you must take a step back and look at this thing as a whole. As the world's economy is becoming molded more and more by individuals like George Shultz, some areas of the country today, such as the Imperial Valley, might see a sharp incline in monetary profits—lots of very colorful and abstract-looking buildings being built, all these modern sexual fantasies popping up (literally) faster than baby-boomers lose their impotency, even on things like Viagra—all signs and symptoms, feelings, that things are doing fantastically well.

The HASS VF4 Vector Drive. If you look in the direction our guide is pointing, you'll see the bit that is used in a program to fix up the sheet of metal in the photo. The tentacles dangling to the right of the main bit piece are nozzles that spray water to help cool and lubricate the piece being drilled. Another 20 bits for the machine are in storage.

Lying underneath all of this you have your greatest minds, the greatest sciences and arts, being lost. Everything that was once normal for a productive society has now become abnormal, and being "insane," "sick," "crazy," or even "dope" become terms for "good" in popular culture. Persons who were once healthy and productive, have now lost all sight of what reality is. Their appearance to the rest of the universe is no longer important, and getting that high from money is the only thing that matters. Underneath it all, you have collapse of infrastructure, such as trains, agriculture, canal systems, health care, and jobs. Where are all the concerned individuals? Why is none of this important to the average citizens? Simply enough, they're hopped up on crack, or something else.

SCIENCE and the LaRouche Youth Movement

What's the Principle?

Now, let's talk simple. All of the aforementioned machine tools involve the principle of circular rotation: Either a hardened material is rotated to high speeds to carve out unneeded area in a project material, or the project material is spinning, as a device is used, once again, to carve out the unnecessary material. Now this sounds pretty basic, right? So does typing a paper on a computer where you can edit mistakes with the touch of a few buttons.

Now, imagine that you didn't have a computer—those of us who have had the pleasure of not having that problem, will need to imagine, and not recall, those images. Think of the productivity lost because of the time spent hand-writing over, and over, and over, different drafts of the same work, rather than making a few minor key strokes.

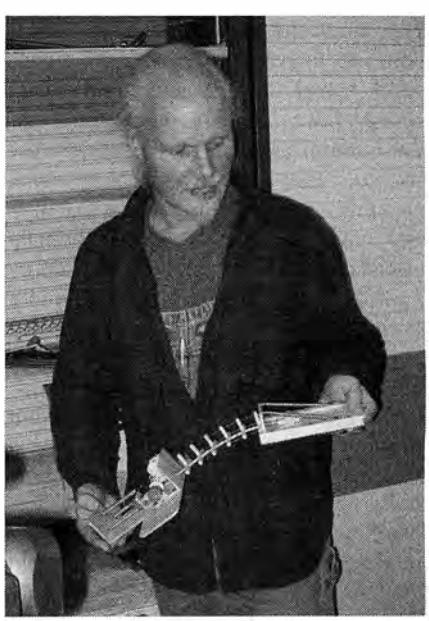
This is what former civilizations had to deal with in creating pottery. Prior to the use of rotation, an individual would have one heck of a time trying to slap together a bowl or vase that would resemble something circular, or even elliptical, let alone the time involved in creating the final product. The pottery wheel allowed the individual to use the principle, whose shape they were trying to re-create. The wheel's ability to spin around gave the worker the power to apply equal curvature (depending on how perfect the circle) to the product being molded.

This new-found power now relieves the pressure on the artisan who was wasting time, straining to ensure a circular-looking product; he is able to use a universal principle to do the work for him, and allow him to spend his newly found time in creating more advanced forms of art and technology with this leap, in the modern science of that time.

Without the discovery of rotation and the modernization of tools based on the new discoveries, not only would we lack the knowledge of technological history derived from the existence of hundreds of thousands of pieces of pottery, and the art history contained on them, but civilization would never have advanced enough to attain the high potential population density we have achieved today. We would not have had the technology necessary to sustain the population now in existence. In other words, a whole lot of us just wouldn't be here today.

A Specifically Human Capability

The ability to create machines and tools is very specific to human beings. Of course, beavers have their dams; but what beaver has the ability to discover a functioning principle in the universe to then *improve* on the type of dams that beavers have been building? That, the ability to use a newly discovered principle, to take it from the mind of the discoverer and interject it into reality, is what makes a tool or



This project, given to the OSU lab by another department at the University, has the task of measuring the motions of the spine.

a machine unique to mankind.

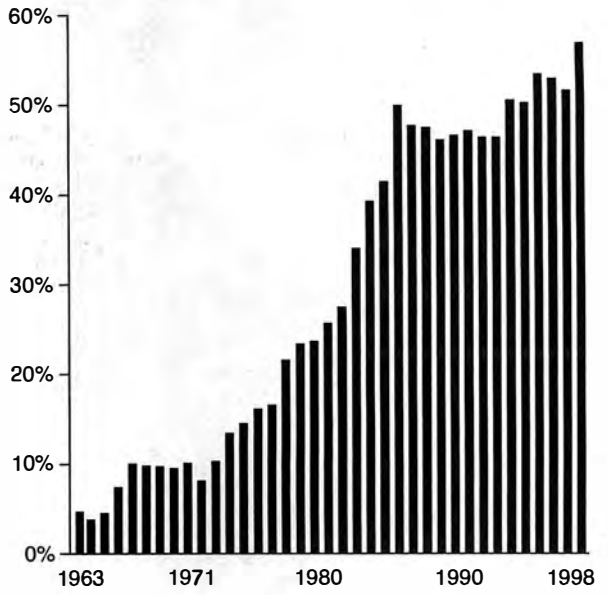
This is the meaning of the idea that we are created in the image of the Creator. This relationship of Creator to his creation, is what allows us, ourselves, to create those things necessary for the species to flourish and overcome any problems we encounter.

Looking around the room at OSU, one can really get a glimpse of history. Walking by technology now long gone, one can form a picture of the speed at which human culture is advancing—not only in the time that we save in producing the goods, but also in the new goods that we can produce to save the consumer and the worker time in their daily lives; thus the necessity of building maglev trains to shorten travel and commute times.

IMPORTED MACHINE TOOLS AS PERCENTAGE OF U.S. MACHINE TOOL CONSUMPTION

Until 1978, the United States still exported more machine tools than it imported. But by 1998, imports were 56 percent of consumption, and total U.S. machine tool consumption fell 41 percent in the first half of 1999 alone.

Source: Association for Manufacturing Technology; U.S. Department of Commerce, Bureau of the Census; *EIR*.



The implementation of these types of breakthroughs, and many others, are necessary for the continuance of LaRouche's idea, the universe's idea, of "no limits to growth": the ability to raise the potential population density of the only cognitive beings known to human beings right now—humans.

The Cult of Free Trade

So, the next time you wonder why 90 percent of your Volkswagen Jetta says "Hecho en Mexico" (Made in Mexico), or why the tag on your green Nautica sweater reads "Made in Vietnam," think about that argument you heard in Economics class: "It's all right (it's 'free trade' at work) to steal the productive powers of another nation so that you can have a nice green sweater."

Think about why your neighbor has to work two part-time jobs, at Starbucks and Walmart, and you're sitting there complaining about why so many people have to squeeze the government for handouts like Medicare and Welfare. For you to drain the labor power of another country, such as Mexico or Vietnam, labor which is needed to produce the goods they *need,* and then wonder why we have lost our productive workforce, and why you hate it when people get Welfare and Medicare, is a fallacy of composition.

All of these problems stem from the same evil in society. This is what the organization founded by LaRouche and many others, has been dedicated to eliminate from society: the Cult of Free Trade.

What must be done to ensure the continuation of our republic, is immediately to revert back to a social process once recognized as the American System, created and employed by individuals such as the foreign-born Alexander Hamilton, the Boston-born Philadelphian Benjamin Franklin, the Ohio-born President William McKinley, and many others—all locations that are now LaRouche Youth Movement strongholds. Whether it be across the world, or across our own land, we are gearing ourselves toward answering the call from history.

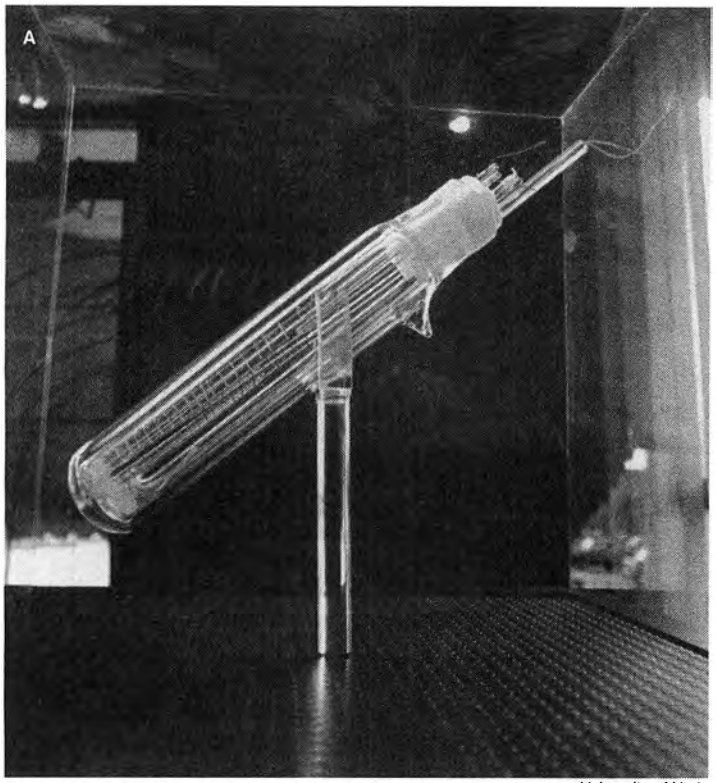
The fact that our own nation is falling apart before our own eyes (even though LaRouche has made history intelligible, unlike the usual school curriculum), that what we are facing is an inevitable collapse of everything we know and love, and that the youth are playing an extremely passive role in this process of growth and development, is a tragedy. But, the LaRouche Youth Movement is destined to ensure a brighter outcome.

This is where the machine tool principle becomes real. Under the type of economic process elaborated by the individuals previously mentioned, this otherwise-forgotten gold mine of knowledge will create a new Renaissance, a Renaissance that will stimulate the intellectual and sensual development of the world's population to make the discoveries necessary to sustain and increase our potential population density, or as so plainly put in a very famous book, to "flourish."

The machine tool principle will allow us to make this happen, acting as the medium between a truly creative individual (not just one with an imagination, but with an understanding of what he is investigating first) and the real world, which he is fighting to understand alongside his fellow man. To do so is to commit oneself to the Greatest Good. This is what allowed the Great California Desert to become a prime place for agriculture, and a winter resort for many. We can also do the same for Africa and every country around the world.

So be it, and that we will do. Come join us—it's fun!

Author Dan Sturman at the Liberty Bell in Philadelphia.

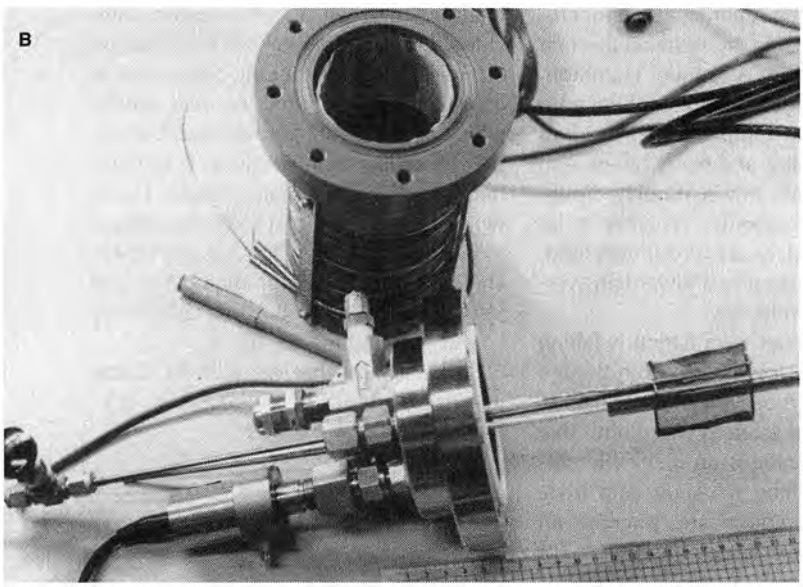


University of Utah

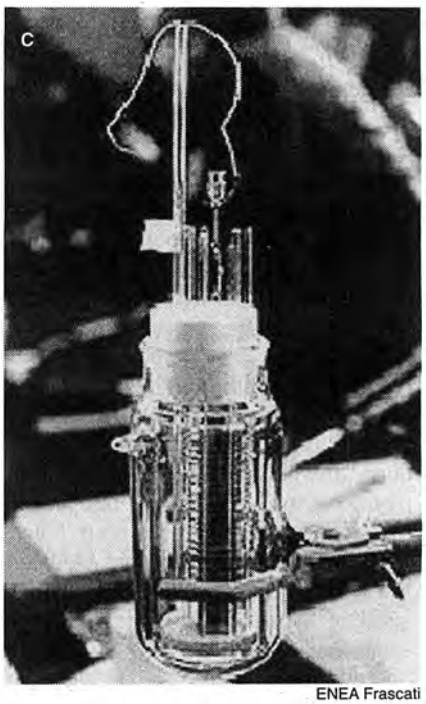
COLD FUSION
The Experimental Evidence

by Dr. Edmund Storms

A guide for both general readers and specialists to the thousands of experiments that establish the overwhelming evidence for cold fusion and suggest some crucial directions for future research.



Courtesy of Dr. Tadahiko Mizuno



ENEA Frascati

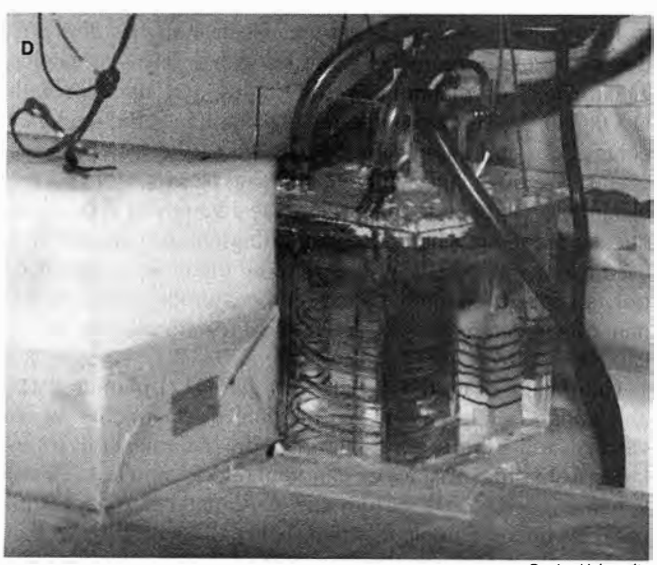
These are some of the many different experimental cells that produced excess heat, tritium, helium, or other anomalous effects. (A) A model of the original Fleischmann/Pons cell. (B) The cold fusion cell of Dr. Tadahiko Mizuno, Hokkaido University, Japan, who was the first researcher to announce successful replication of the Fleischmann/Pons experiment. (C) A cold fusion cell from the ENEA group, Frascati, Italy. (D) The cold fusion cell of Dr. Akito Takahashi, Department of Nuclear Engineering at Japan's Osaka University. (E) A bank of cold fusion cells at Texas A&M University, which produced tritium. (F) One of the author's test cells.

My interest in cold fusion began shortly after Professors Stanley Pons and Martin Fleischmann announced their claims in 1989, while I was but an ordinary conventional research scientist working at Los Alamos National Laboratory.

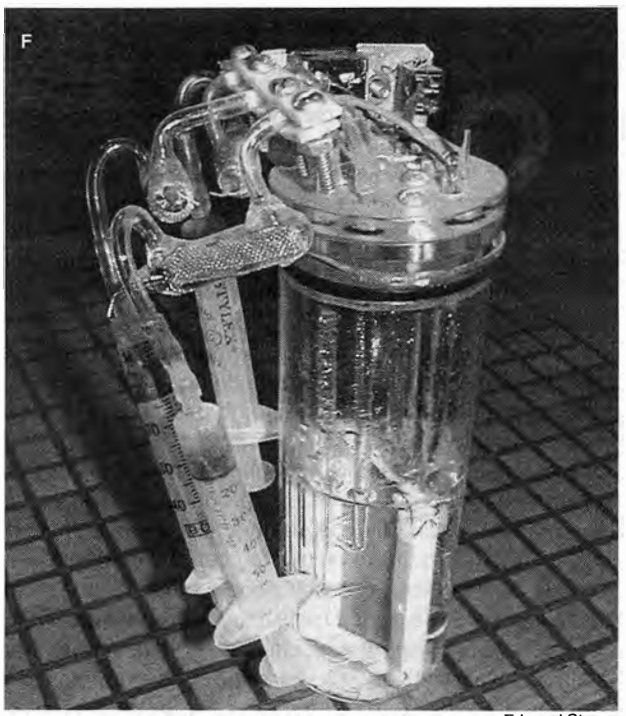
On March 23, 1989, Pons and Fleischmann, two experienced electrochemists, went public with the results of an extraordinary experiment they had repeated numerous times in their University of Utah laboratory. The Pons-Fleischmann experiment employed a simple electrolytic cell of the type one uses to dissociate water into its constituent elements. The device consisted of a cathode (negative electrode) of metallic palladium, one of a number of metals capable of absorbing large quantities of hydrogen gas into its crystal lattice, and a platinum anode. The electrolyte was a solution of heavy water, or deuterium oxide (deuterium being the first isotopic form of hydrogen, containing one neutron in the nucleus). By suitable "loading" (that is, absorption of deuterium into the metal lattice) of the palladium cathode, and application of electrical current in the proper amount and time periods, the cell was found to produce heat considerably in excess of the heat-equivalent of the electricity input. Fleischmann and Pons suggested that the only possible source of the considerable excess heat detected had to be some hitherto unknown type of nuclear fusion.

The controversial phenomenon, soon studied and reproduced by many others, and in many different ways, was first known as *Cold Fusion,* and then by the additional names of *Low Energy Nuclear Reactions* (LENR), or *Chemically Assisted Nuclear Reactions* (CANR). It involves the proposed ability to initiate a wide variety of nuclear reactions in solid materials using much lower energies than previously thought possible.

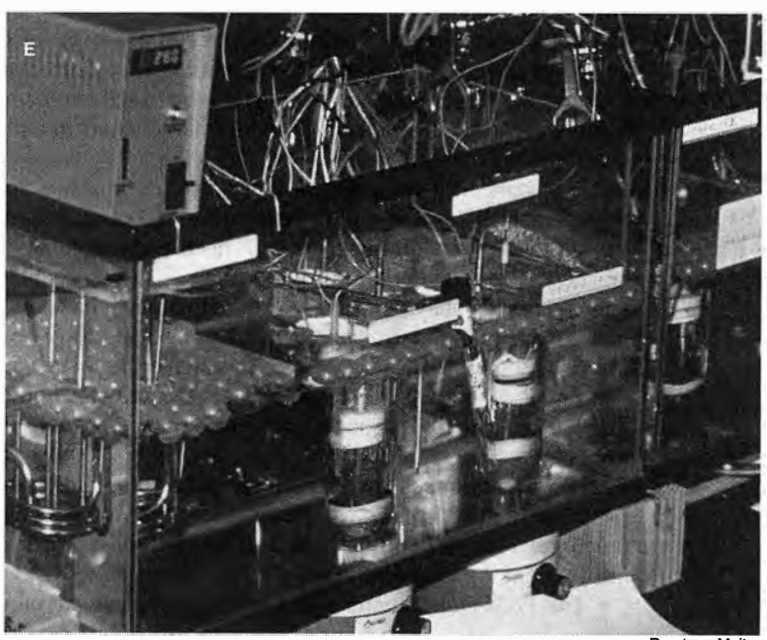
To bring about nuclear fusion, two or more positively charged nuclei must be brought extremely close together so that they will fuse into one heavier nucleus. The problem in achieving this is that the repulsive (Coulomb) force between



Osaka University



Edmund Storms



Ramtanu Maitra

EDITOR'S NOTE: This article is adapted from the author's paper, dated January 2003, which appears on the website www.lenr-canr.org under the title "A Student's Guide to Cold Fusion." Hyperlinks to many of the references cited in this paper are available at that site.

two like charges increases exponentially as their distance apart becomes less, giving rise to the phenomenon known as the Coulomb barrier. If this can be overcome by some means, the fusion of two nuclei can release enormous amounts of energy, such as occurs in the thermonuclear (or so-called "hydrogen") bomb. For decades since the first thermonuclear explosion in 1952, efforts to produce controlled thermonuclear fusion focussed on finding means to contain and bring together two light nuclei at very high temperatures—hence the term "hot" fusion. The 1989 Pons-Fleischmann experiment first gave hope of the possibility of achieving "cold" fusion. Rather than using brute force to move nuclei to within reaction distance, apparently a mechanism exists in a lattice structure that is capable of circumventing any Coulomb barrier, allowing certain nuclei to interact.

Of the numerous attempts to replicate the claims of Pons and Fleischmann, I was fortunate in producing tritium as well as anomalous energy. There is nothing like seeing a phenomenon for oneself to make a person believe that it is real, regardless of what less observant people might claim. Seeing many fellow scientists acting foolish and self-serving provided an additional but disappointing education. Since retiring from Los Alamos National Lab, 12 years ago, I have continued to investigate the subject, to write papers, including several scientific reviews, and to lobby for acceptance of the phenomenon.*

Although skeptics often point to failures as a way to reject the process, actually a failure in one laboratory seldom casts doubt on work in another, unless the two use exactly the same instruments and techniques. Failure has many fathers in addition to the claim being false.

This discussion is designed to be a guide for amateurs and professionals alike. The claimed effects are accepted as being real, although not well understood or necessarily accurate in their reported magnitude. This paper intends to show important patterns of behavior, to suggest ideas that might have been overlooked, and to give a student some understanding of how to replicate the claims. The reader can make the final judgment as to whether such a large and consistent collection of observations can be produced by error, chance, or prosaic processes.

New work has revealed several incorrect assumptions in the earlier approaches, that have led research into unproductive directions. I suggest that theories and future studies now take into account the following:

- The Pons-Fleischmann effect occurs in the surface of an electrolyzing cathode, not in bulk material.
- Active material causing the Pons-Fleischmann effect is not β-PdD (the β phase of the palladium crystal lattice when deuterium is absorbed into it) of any composition, but is a complex compound of unknown but high composition, and of unknown structure.
- Nuclear reactions are found to occur in many materials treated in a variety of ways, and not just when palladium and deuterium are present.
- An environment consisting of nanosized particles is very frequently observed when nuclear effects occur.
- All isotopes of hydrogen can be involved in the cold fusion process.

In addition, I suggest that all past explanations based on the ideal properties of β-PdD must be abandoned as being hopelessly inadequate. Until the nature of the real world, in contrast to the ideal, imagined world, is addressed by theory, the field will continue to stagnate. These conclusions, some my own and some shared by others, provide the basis for this paper.

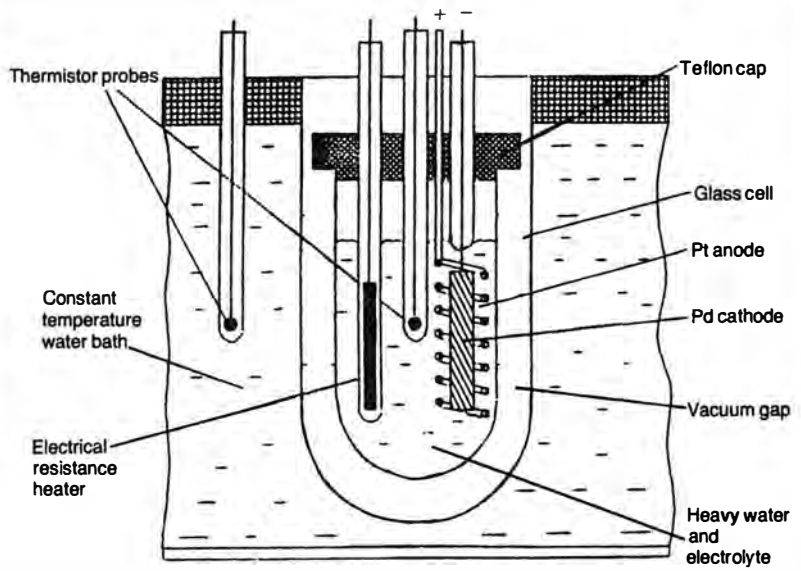
1. Overview of the Evidence

Palladium deuteride was once thought to be unique in its ability to host such reactions. Many other metals and metal alloys now have been found to produce the same novel effects. However, all of these anomalous effects are sensitive to the chemical environment in which they occur. Apparently, chemistry is as important as physics to this phenomenon, a fact that is frequently ignored.

The *nuclear-active environment* has been generated many different ways and exposed to a range of applied energy from several sources. The first reported method[2] used electrolysis to load palladium with deuterium. Electrolysis has also produced success using nickel cathodes with an H_2O-containing electrolyte,[3,4] platinum with D_2O,[5] and titanium with D_2O.[6] Increased temperature,[7-9] applied radiofrequency energy,[10] and laser light[11-13] appear to enhance the effects. Use of voltage sufficient to create plasma[14,15] in the electrolyte has been found to generate a variety of anomalous nuclear reactions when palladium, tungsten, or carbon[16] is used as the cathode. The kind of atom dissolved in the electrolyte and subsequently plated on the cathode plays a dominant role in determining which nuclear reaction occurs on the cathode.

Thin layers of material plated on glass,[17] platinum,[18] and copper[19,20] have also become nuclear-active when electrolyzed. Simply exposing finely divided metal of various kinds to hydrogen isotopes can generate anomalous effects. When exposed to deuterium gas, nanometer-size palladium particles become nuclear-active. This palladium powder can be free-standing as "palladium-black"[21] or attached to a carbon surface,[22] as in a conventional hydrogen catalyst. A flux of deuterium caused to pass through a 40-nm layer of

* The large collection of references (numbering nearly 3,000) acquired in this effort was made into the Library on www.lenr-canr.org. With essential help provided by Dieter Britz and Jed Rothwell, this collection of literature will be kept up-to-date as the field grows. Readers wishing a nontechnical understanding, are referred to the book *Excess Heat: Why Cold Fusion Research Prevailed,* by Charles Beaudette,[1] or the nontechnical section of www.lenr-canr.org. For a recent review of cold fusion, see *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy,* by Steven B. Krivit and Nadine Winocur (Los Angeles: Pacific Oaks Press, 2004).



Source: Adapted from Bockris et al.

SCHEMATIC OF A FLEISCHMANN-PONS CELL

This is the type of cold fusion apparatus used by Fleischmann and Pons. A platinum anode (wire) winds loosely around a palladium cathode (rod shaped) inside a glass jar of heavy water (99.5 percent D_2O). A small amount of lithium-deuteroxide is added to the heavy water electrolyte to help the current flow, and there is a low-voltage battery between the two electrodes.

The electrical forces in the cell between the negative (Pd) and positive (Pt) electrodes separate atoms of oxygen and atoms of deuterium from the heavy water molecules. Deuterium atoms are absorbed in the palladium, and some escape as a gas.

palladium can also generate a variety of nuclear reactions,[23] depending on the kind of atoms dissolved in the palladium.

Energetic ions, obtained by discharge in gas containing hydrogen isotopes[24, 25] or by ion bombardment,[26-35] have been used to initiate nuclear reactions. In all cases, ion energy is far below that thought necessary to cause a significant nuclear effect.

Certain complex metal oxides[36, 37] are capable of dissolving some deuterium, which can be electrodiffused within the structure by applying a voltage. Anomalous energy has been generated using this method. Electrodiffusion of D^+ in β-PdD may also produce anomalous heat.[38-42]

Bubbles generated by sonic energy passing through a liquid can collapse on a metal surface. When this happens, the bubble content is injected into the metal as plasma. Use of heavy water injects a mixture of D^+ and O^{--}, which produces anomalous nuclear products and heat in a variety of metals used as the target.[43-45] Normal water may produce similar novel effects, although replication has yet to be successful.[46]

Anomalous effects have been seen during a variety of chemical reactions when deuterium is present.[47, 48] Sudden heating of titanium charged with D_2[49] or cooling of titanium in D_2 gas[50, 51] results in neutron emissions. Many chemical reactions involving deuterium have been reported to generate neutrons, including the setting of Portland cement. Nuclear effects have also been reported to involve biological systems in the presence of both D_2O[52] and H_2O.[53, 54] Although the number of nuclear events is small in these environments, conventional theory would have none produced.

Only a few studies have measured nuclear products at the same time as anomalous energy. These measurements show a direct relationship between energy and helium-4 production when deuterium is present (as described in Section 3), and a relationship between transmutation products and heat. On the other hand, tritium or neutron emissions are seldom associated with detected heat, although occasionally X-ray emissions are observed. Apparently, the path taken by the fusion reaction is much different in a lattice as compared to when energetic plasma is used.

Hydrogen is also found to be nuclear-active in some environments. Anomalous effects are produced by specially treated nickel surface when exposed to hydrogen gas.[55] Nickel, when it is repeatedly loaded and deloaded using hydrogen gas, appears to produce tritium.[56] Hydrogen can also produce transmutation products and detectable energy.[57-65] Even tritium, when reacted with finely divided titanium,[66] experiences a change in its decay rate.

This is only a brief sample of conditions reported to produce strange effects, many of which have been done with enough care and duplication to support the claims. Only a few of the many replications are noted here.

Unfortunately, the nature of the nuclear-active environment has been difficult to discover, because the reactions only occur in very small regions that have properties much different from the surrounding bulk material. More detail will be provided in later sections.

New methods are being explored, and old methods are being replicated. Skeptics predicted that cold fusion was an artifact, and would disappear when better instruments and techniques were used, but this has not happened. On the contrary, the effects have been more widely reported, and at higher signal-to-noise ratios. Clearly, the unique mechanism can be initiated many different ways, in many chemical structures, and involve all isotopes of hydrogen. The challenge is to determine what these structures and mechanisms have in common, not to reject them because they are novel.

2. The Measurement and Production of Anomalous Energy

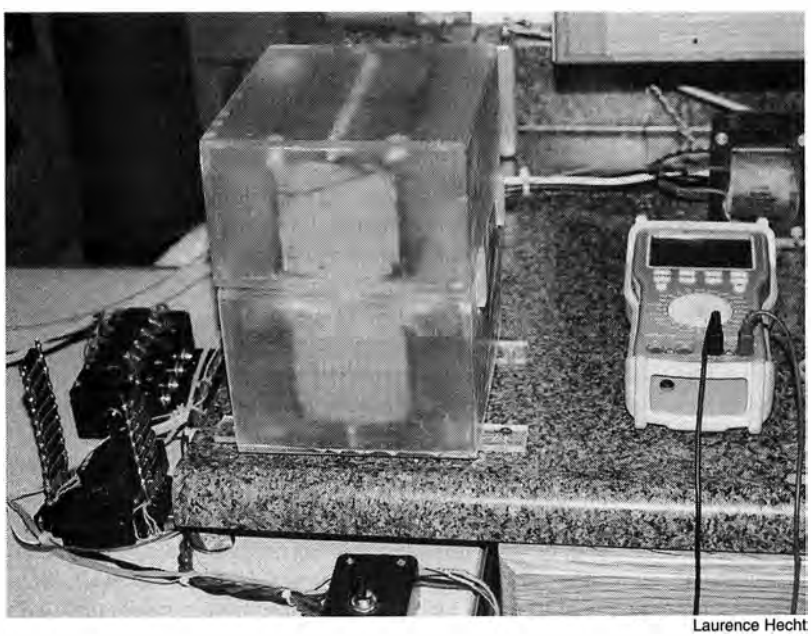
2.1 Explanation of the Calorimetric Method

Demonstration of energy production requires use of a calorimeter. Several kinds have been used, which include isoperibolic, flow-type, and Seebeck. Because calorimetry is a mature science, its errors and limitations are well known. However, not all measurements of the LENR effect have taken advantage of this knowledge. Anyone attempting such measurements or evaluating the claims, must first learn what is known about the method being used.

Isoperibolic calorimetry uses the temperature difference across a thermal barrier to determine the amount of thermal power being generated within the barrier. Accuracy depends on ΔT being known over the whole barrier area and remaining stable. Errors can be introduced when the wall of an electrolytic cell is used as the thermal barrier and temperature is measured within the electrolyte. Unexpected temperature gradients are usually present, which compromise the measurement. Under these conditions, accuracy depends on design of the cell, location of the temperature sensors, and stirring rate.[67] This method requires suitable calibration, usually by electrolyzing an inert electrode. Use of an internal heating element for calibration is not recommended, especially in the absence of stirring or simultaneous application of electrolytic current. A refinement of this method uses a thermal barrier external to the cell.[68, 69] Such a design is much less affected by gradients within the cell, and can be made very sensitive to generated thermal power.

A flow-type calorimeter captures released thermal power in a flowing fluid and measures the resulting temperature change of this fluid. If no energy is lost from the calorimeter, the amount of thermal power can be obtained using flow rate, temperature change, and heat capacity of the fluid—the so-called absolute method. However, complete capture of all energy is very difficult. Consequently, the calorimeter must be calibrated by using an internal heating element, or by electrolyzing an inert electrode. The advantage of this method rests on its being relatively insensitive to where energy is generated within the cell. However, isolating the calorimeter from the environment and achieving a constant, known flow rate, can be a challenge.

A Seebeck calorimeter generates a thermoelectric voltage produced by the temperature difference across a thermal barrier containing thermocouples. This barrier completely surrounds the heat source, with the outside kept at constant temperature. Because all parts of the surrounding wall contain the same density of thermocouples connected in series, loss of energy through each part of the thermal barrier is summed, regardless of where heat energy leaves. Unfortunately, not all locations are completely equivalent. As a result, the calibration constant is sensitive to where the heat source is located within the thermal envelope. This problem can be reduced by installation of a fan. On the other hand, this method is insensitive to where heat is generated within a cell containing the heat source. Only the position of the cell must be kept constant within the thermal envelope. This method also must be calibrated.



Laurence Hecht

A Seebeck calorimeter which generates a thermoelectric voltage, produced by the temperature difference across a thermal barrier containing thermocouples. This array was built by Dr. Storms.

Many variations on these methods have been used, some with good success. Reliable measurement of anomalous power of ±50 mW (milliwatt), superimposed on 15 watts of electrolytic power, can be routinely achieved. Some special designs are reliable below 1 mW when less electrolytic power is applied.

2.2 Methods for Producing Anomalous Energy

Electrolysis

The first claim for anomalous heat generation was provided by Pons and Fleischmann,[2] using electrolysis and an isoperibolic calorimeter. This work was subjected to considerable analysis and debate, but was eventually found to be sufficiently accurate to support their claim.[70] Since this work was published, well over 100 claims for anomalous energy using electrolysis have been published, many finding more than one sample to be active. Unfortunately, only about 37 of these publications provide enough information to allow an analysis of possible errors. Most of

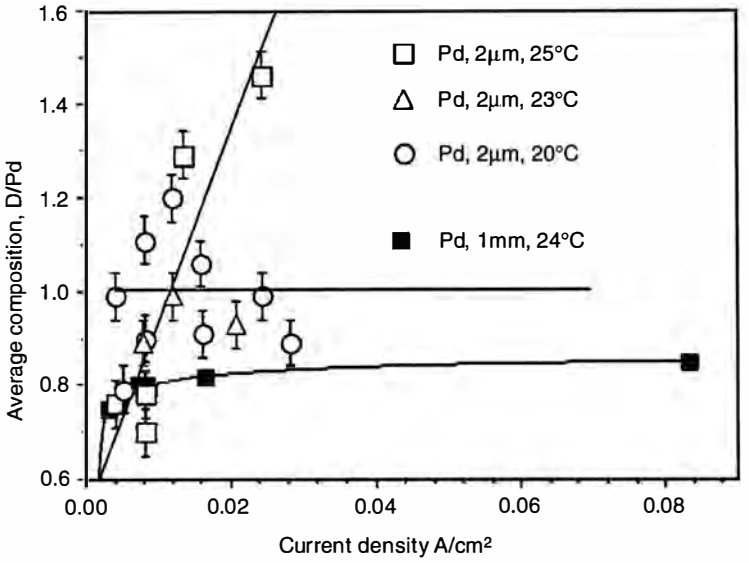


Figure 1
MEASUREMENTS OF THIN FILM COMPOSITION AS REPRESENTATIVE OF THE TRUE SURFACE COMPOSITION

these studies measured several samples of palladium, with some being active and some inactive. These reports are tabulated by Storms,[71] who also evaluated the suggested prosaic explanations.

Until recently, anomalous energy was assumed to be generated within the β-PdD structure. Many recent observations indicate that only small regions in the surface are active, and these turn rapidly off and on.[72] Presumably, a region starts to generate energy, heats up, expels deuterium, and turns off. Rapid repletion produces apparent steady energy. Occasionally, energy density is sufficient to cause local melting. This region consists of a complex alloy containing many elements, but little palladium. More will be said about this situation below.

When the electrolytic method is used with a palladium cathode, everyone who makes suitable measurements always sees six characteristic behaviors. These are:

(1) The average D/Pd ratio of the entire cathode must exceed a critical value. This value differs somewhat between studies, because only the average composition can be determined, which depends on the method used and the shape of the cathode. Typically, the average critical value lies between D/Pd = 0.85 and 0.90. Infrequently, compositions above this range are found to be inactive for unknown reasons. The actual composition of the active surface appears to be above D/Pd = 1.5, and perhaps as high as D/Pd = 2.0,[73, 74] as shown in Figure 1. Failure to reach a sufficiently high composition on the surface, regardless of the average composition, can explain occasional failure of highly loaded samples.

(2) Current must be maintained for a critical time. This time is variable, and presumably depends on how rapidly the surface can acquire the active structure and/or composition. This time is short for very thin layers of palladium, while it can be as long as months for bulk palladium. Failure to wait the necessary time is one reason that some people have not seen the effect.

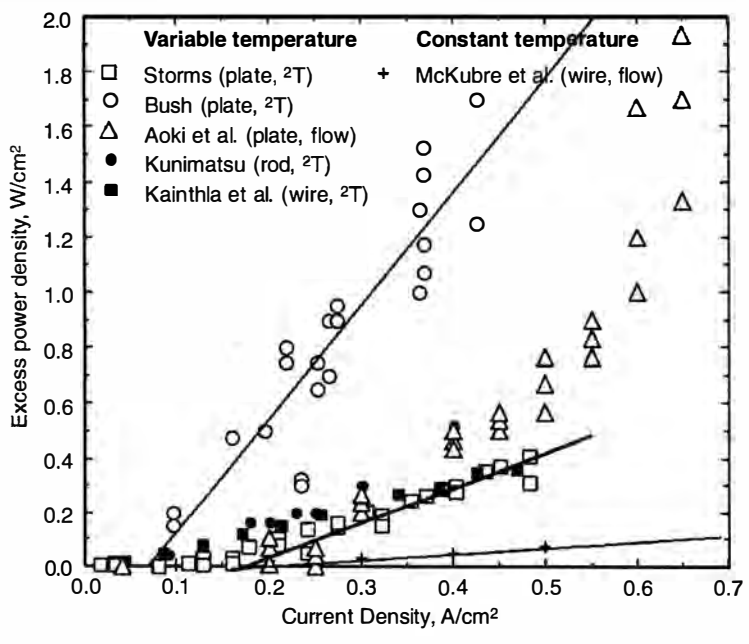


Figure 2
EXAMPLES OF THE EFFECT OF CURRENT DENSITY ON EXCESS POWER PRODUCTION

(3) Current density must be above a critical value, as shown by a few examples in Figure 2. Applied current determines the surface composition, hence the nature of the active structure. A value above 150 mA/cm² is usually found for bulk palladium. Presumably, currents above this value are required to compensate for the loss of deuterium from the back side of the active surface. Thin layers of palladium deposited on platinum do not require such a high critical current, because backside loss is trivial, provided that the layer is well bonded. These samples show anomalous energy at currents near zero.

(4) Inert palladium can sometimes be activated by addition of certain impurities to the electrolyte. These impurities are proposed to help the surface achieve a higher deuterium content and/or suitable structure.

(5) The effect occurs in only a small fraction of samples, but more often in certain batches

than in others.[75] This is consistent with the fact that all physical properties of palladium are found to be batch-specific, making this metal highly variable in its general behavior, even in conventional applications. Electroplated palladium has a higher success rate, although it also can be highly variable depending on conditions used during plating.

(6) Presence of too much light water in the D_2O electrolyte will stop the reaction.[76] Heavy water is highly hygroscopic, so that exposure to laboratory air will quickly render the material useless. This oversight explains many early failures.

In a few cases, the same batch of active palladium was studied in different laboratories.[76] On one occasion, the same active sample was studied in different laboratories.[77] Anomalous heat was obtained in each case. In fact, the author has found that once an active cathode is produced, it can be used to produce anomalous results at will, with total reproducibility.

The electrolytic method has met all of the criteria science requires to accept anomalous claims. Anomalous heat production has been independently duplicated many times, with values frequently far in excess of expected error; the results show the same patterns of behavior regardless of the apparatus used; and reasons why replication is difficult have been identified. However, the source of anomalous energy is not revealed by such studies, nor is knowing its source required to accept the observations. Later chapters will explore evidence supporting a nuclear source.

Gas Loading

Arata and Zhang[78] at Osaka University in Japan were the first to generate anomalous energy using finely divided palladium. This powder is contained in a palladium capsule, which is pressurized with very pure deuterium gas generated by electrolysis. The claim was duplicated at Stanford Research Institute[79, 80] with Professor Arata's help.

After this work was published, Case heated a commercial palladium catalyst in deuterium gas and reported anomalous energy and helium. This claim was also duplicated at Stanford Research Institute[79] with Case's help.

Both results are difficult to replicate, because characteristics of the active material are critical, especially particle size and purity.

Recently, Iwamura et al.[23] at Mitsubishi Heavy Industries in Japan deposited a thin layer of palladium (40 nm) on a layer of CaO, which had been deposited on palladium. When deuterium was caused to diffuse through this sandwich, several nuclear reactions were detected, including excess energy.[81]

Electrodiffusion

Electrodiffusion is a process whereby ions dissolved in a material are caused to move under the influence of applied voltage. The enhanced diffusion rate is proportional to applied voltage and to the amount of charge on the ion, thereby allowing the effective charge of a dissolved ion to be determined.[82] The effective charge on hydrogen in $PdH_{0.67}$ is $+0.30\pm0.05$,[83] with an apparent increase in positive charge at higher H/Pd ratios.[84, 85]

This method was first applied to an oxide environment by Mizuno,[36] and later duplicated by Professor Oriani[37] with Professor Mizuno's help. Professor Preparata[86] first applied the method to palladium deuteride, at which time it was called the Coehn-Aharonov Effect. Workers in Italy have further refined the method.[87, 88] In each case, anomalous energy is produced.

The net effect of ion diffusion driven by applied voltage, and normal diffusion driven by a concentration gradient, may be identical as far as the nuclear mechanism is concerned. Consequently, a flux of deuterium ions that is almost always present may aid in energy production, as suggested by McKubre,[89] just as does an applied voltage.

Sonic Method

Stringham,[90] with the assistance of George, pioneered use of the sonic method to load solid metals with deuterium. Other workers have tried loading materials suspended within D_2O.[91] Evidence for nuclear products was reported in each case, and anomalous energy in the former study. Recently, Professor Arata has replicated the results in Japan using a similar method. However, the method has proven difficult to replicate by other people. This method is not the same as used by Taleyarkhan et al.[92] to generate neutrons *within* the collapsing bubbles. In their case, temperatures of thousands of degrees, reached just before the bubble vanishes, may produce a brief "hot" fusion process, but not "cold" fusion.

A number of reports of anomalous heat using mechanically generated cavitation have been reported using light water.[46, 93] These claims have not been replicated, although attempts have been made.

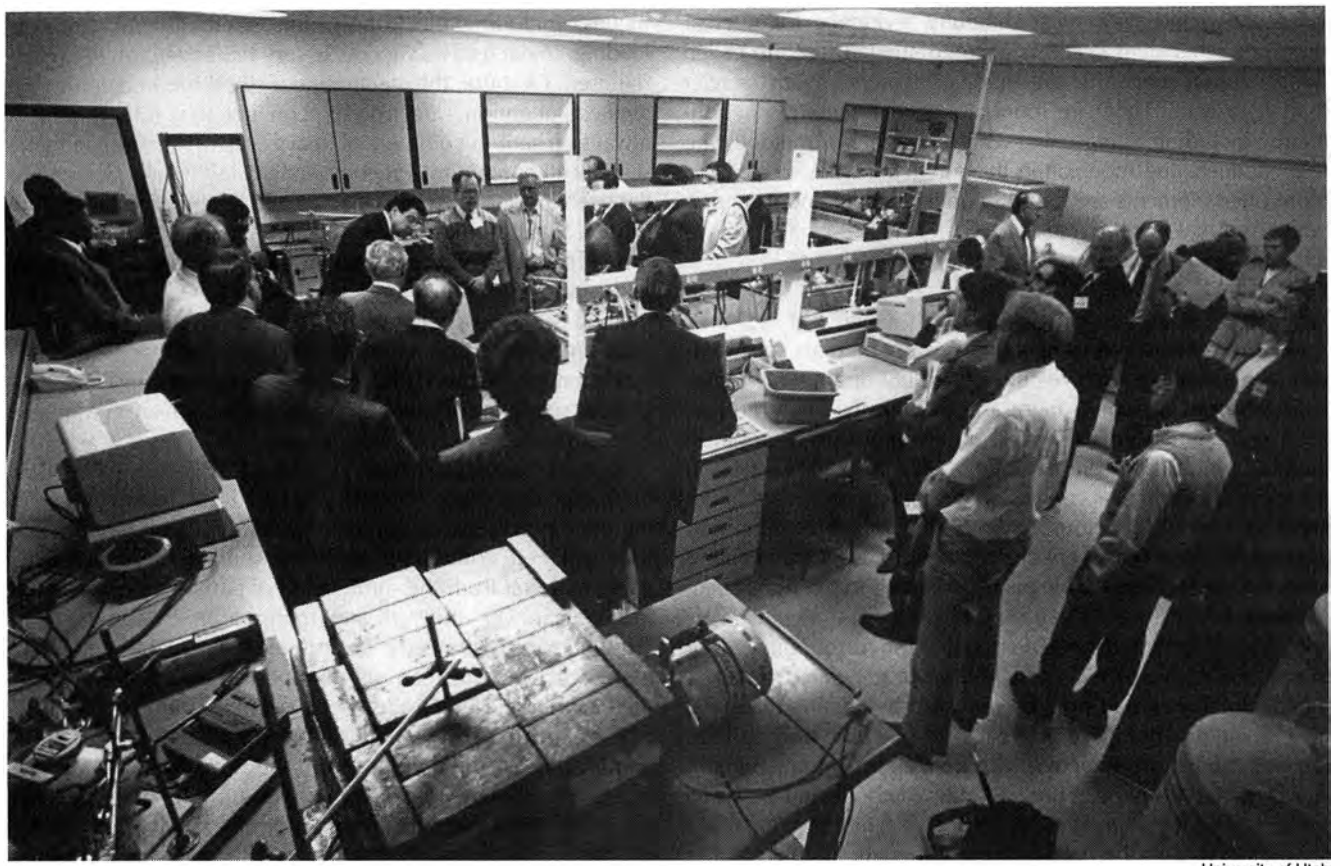
3. Detection and Measurement of Nuclear Products

Once claims for anomalous energy are accepted, identification of its source is the next problem. Because of its large magnitude, and the absence of an obvious chemical source, Pons and Fleischmann suggested the energy came from fusion of two deuterons. This suggestion immediately got them into trouble with the physics community.

The fusion reaction has three potential paths, as shown below. Each path contributes the indicated fraction when fusion is caused to occur at high energy, as in plasma—in other words, as "hot" fusion. The branching ratio between the neutron and tritium paths is energy-independent above 20 keV, but may be sensitive to applied energy at lower energies,[94] and to the chemical environment as well.[95]

Nuclear Reactions Resulting from Fusion of Deuterium

Reaction	Energy	(MeV)	Fraction
d + d =	Helium-4 + Gamma	23.9	<0.01
d + d =	Tritium + Proton	4.03	0.5
d + d =	Helium-3 + Neutron	3.27	0.5



University of Utah

Scientists and journalists tour a cold fusion laboratory at the University of Utah's National Cold Fusion Institute in 1989.

These branches were initially thought to occur with the same fraction when anomalous energy was made in a Pons-Fleischmann cell. Consequently, early rejection of the claims was based on the many studies that failed to detect significant neutron emission or tritium production.

Search for a nuclear product then focussed on helium-4, and was rewarded by early success. This work also is rejected, because the required gamma emission is absent. Helium-4 can not be produced from simple fusion unless the momentum of the two reacting nuclei can be shared between two emitted particles, in this case a photon and a helium nucleus. Suggestions that this energy might be shared with atoms or electrons in the environment are also rejected, because the time needed for this transfer is considered too great compared to the extremely fast energy release from a fusion reaction. Nevertheless, evidence for helium production continues to accumulate.

The amount of detected tritium is never enough to account for observed energy, and it is seldom detected at all, even when anomalous heat is being made. Nevertheless, it has been observed many times, and it is clearly anomalous, even when the amount is small.

Tritium detection is a mature science that is able to measure concentrations well below those found in cold fusion cells, a fact that eliminates measurement error as an explanation. Initially, tritium was dismissed as being caused by contamination from the environment. Use of sealed cells eliminates this possibility. Palladium was proposed to contain tritium as a leftover from its assumed use in weapons production. Careful analysis of commercial tritium, and use of virgin material, eliminates this possibility.[96] The normal tritium content of D_2O can be concentrated by electrolysis when a recombiner is not used. Although this effect might explain a few observations, it can not explain them all, because most successful studies now use a recombiner. Fraud was even suggested[97] in a futile attempt to discredit work at Texas A & M University.[98] At the present time, no plausible prosaic process explains the occasional increase of tritium in sealed cells containing a recombiner. Although many chemical environments have been explored, no nuclear-active environment has been identified to which tritium production can be related.

Neutrons are detected, usually as bursts, but the rate suggests this fusion path is the least used by the cold fusion process. Indeed, neutrons might not even result from cold fusion at all. A process called *fractofusion* has been suggested, whereby cracks produced within a material can generate sufficient voltage gradient and/or temperature within the crack to initiate a local "hot" fusion reaction.[99-101]

Even though most of the nuclear energy disappears as heat, some is retained as emitted energetic particles and electromagnetic radiation. However, the amount of radiation and its energy are much less than expected based on the behavior of "normal" nuclear reactions.

Recently, and with great difficulty, evidence for nuclear reactions other than fusion is accumulating. These are called transmutation reactions and involve elements much heavier than hydrogen. They are found to occur in many environments, including living cells, when a variety of methods are used. Indeed, the more often these reactions are sought, the more often elements are found in unexpected amounts and/or with abnormal isotopic ratios.

3.1 The Nuclear Products

Helium

Helium is measured using a high-resolution mass spectrometer. A major error involves the possibility of air, which contains 5.6 ppm helium-4, being mixed with the analyzed gas. Such contamination is revealed by the presence of argon in the gas, which is present in air at 0.94%. A memory effect in the mass spectrometer can distort measurement if care is not taken to flush out previously admitted helium. Deuterium gas (D_2), which has a mass very close to helium, is removed chemically before the remaining gas is submitted to the mass spectrometer.

Helium is expected to reside in either the surrounding gas or in the metal structure. When helium is generated within a metal structure, it can only be removed by heating the metal near its melting point.[102] Because at one time bulk palladium was thought to be active within its entire volume, helium was extracted from the entire palladium cathode and analyzed by mass spectrometry. This work is summarized in a review.[103] The observed helium, although anomalous, has been attributed to either air contamination during analysis, or ubiquitous dissolved helium. Later, measurements were made of helium present in gas evolving from electrolytic cells. At least five independent measurements[104-108] show a relationship between amount of energy and helium produced. Recently, helium also has been detected after energy production in gas-loaded cells containing finely divided palladium.[79, 109] Because most helium appears in the gas rather than in the metal, it is safe to assume that helium is produced very near the surface rather than in the bulk.

Tritium

Tritium is radioactive, decaying by beta emission to helium-3 with a half-life of 12.3 years.[110] Tritium is normally detected by placing it in an organic fluid that gives off light upon passage of the beta particle. This light is detected by a photomultiplier tube and presented as an energy spectrum and total number of events. Chemiluminescence, that is, light produced by a chemical reaction, is a potential source of error that can be eliminated by waiting for a suitable time, or vacuum distilling the sample. The accumulated helium-3 can also be detected using a mass spectrometer, or the beta current can be measured using an ionization cell and a sensitive electrometer. Because the emitted beta particle is barely able to pass through a piece of paper, direct detection can be difficult. Although detectable tritium is present in the normal environment, as a residue from atom bomb tests, the amount is much less than that found in cold fusion cells.

Tritium has been produced using several different techniques, including electrolysis, ion bombardment, and gas loading. In each case, success is very dependent on the material used. Of these, the electrolytic method has been given the greatest attention. Electrolysis concentrates tritium that is always present in commercial heavy water. Therefore, either a sealed cell containing a recombining catalyst must be used, or the evolving gas must be collected and analyzed separately for tritium. Many studies have calculated the increased amount of tritium expected from the known separation factor,[111, 112] and subtracted this amount from the measurement. This method is the least accurate of the three, but satisfactory when large amounts of tritium are found. Three studies deserve special attention because of the unique understanding they provide. A summary of other measurements is given in a review by Storms.[103]

Tritium from Electrolysis: Will et al.[113] used sealed glass cells containing a recombiner, so that environmental contamination was not possible. To evaluate this possibility, an identical cell containing H_2O was run at the same time, using material from the same batch of palladium. These control cells never showed any increase in tritium content. Tritium analysis showed more tritium in the electrode than in the electrolyte. This can only happen when tritium is generated within the electrode, because deuterium quickly displaces tritium from palladium during electrolysis.[114] Similar pieces of palladium from the same batch were analyzed and shown not to contain tritium.[96] No plausible source of tritium has been suggested to explain these observations. The amount of anomalous tritium was far in excess of the sensitivity and error of the detector. Matsumoto[115] also found tritium when a D_2SO_4 electrolyte was used with a palladium cathode.

Storms[114, 116] showed how tritium behaves in an electrolytic cell. Tritium contained initially in the palladium cathode as contamination is quickly released by electrolysis and appears in the evolving D_2 gas. On the other hand, tritium that results from the cold fusion process appears in the electrolyte, with much less in the gas. This behavior eliminates tritium dissolved in the electrode as being the source of anomalous tritium in the electrolyte when cells are used without a recombiner, and is consistent with tritium being produced on the surface of the cathode during the cold fusion process. Of course, when a recombiner is used, the evolving gas is converted to $D(T)_2O$ and mixed with the electrolyte, thereby making a distinction between the two sources impossible.

Bockris and his students[117] found tritium in a cell lacking a recombiner and using a palladium cathode and D_2O. Shaking the cell could stop tritium production; increasing cell current (voltage) could increase the production rate. Copper, from an exposed wire, was found on the cathode after the study. This was thought to occur as dendrites, removal of which, upon shaking, was thought to interrupt production.

Anomalous tritium has also been reported in light water cells containing a nickel cathode.[118]

Tritium from Ion Bombardment: Claytor et al.,[24] in a well-documented and through study done at Los Alamos National Laboratory over many years, generated tritium by subjecting certain alloys to pulsed discharge in D_2 gas at mod-

Marjorie Mazel Hecht

Martin Fleischmann (at left) shows Rep. Marilyn Lloyd a sample cold fusion electrochemical cell at Congressional hearings held April 26, 1989, by the House Subcommittee on Energy Research and Development, which Lloyd chaired. Stanley Pons is at Lloyd's left. During his testimony, Fleischmann stressed that cold fusion should not be seen as a replacement for the existing magnetic and inertial confinement fusion programs.

est voltages (<7,000 V). The amount of tritium generated depends on the material used as the cathode, with complex alloys being more productive than pure palladium.

Tritium from Gas Loading: Clarke[80] detected ^{3}He in an Arata-type cell provided by McKubre,[79] which could be explained by decay of tritium produced during the initial study. During this study, the palladium cell containing palladium-black was loaded with very pure D_2 gas generated by electrolysis. Nothing else was done to the cell, and the quantity of ^{3}He was not consistent with tritium being present before the study. Itoh et al.[119] loaded palladium with deuterium, coated the material with copper, then deloaded by heating in vacuum. Tritium emission increased substantially when the initial average composition was over D/Pd = 0.85.

Tritium was found in nickel wires after being electrically heated and cooled many times in hydrogen.[118] The resulting hydride layer, in which tritium was found, was 20 to 30 nm thick.

Neutrons

Neutrons are detected using several types of counters, including those containing ^{3}He or BF_3 gas. Neutrons reacting with these gases produce bursts of energy that are detected as voltage pulses. An energy spectrum can be obtained using NE213[120] or Li-glass scintillation[121] detectors, which detect the gamma ray emitted when a neutron reacts with lithium within the detector. Because the number of neutrons emitted from a cold fusion cell is so small, great care must be taken to eliminate false counts produced by electrical discharge, cosmic rays, or normal sources in the environment.[122-124] Occasionally, very large bursts are seen for a brief time. These bursts are seldom associated with measurable heat or tritium production. When they are, the n/t ratio is as small as 10^{-9}.

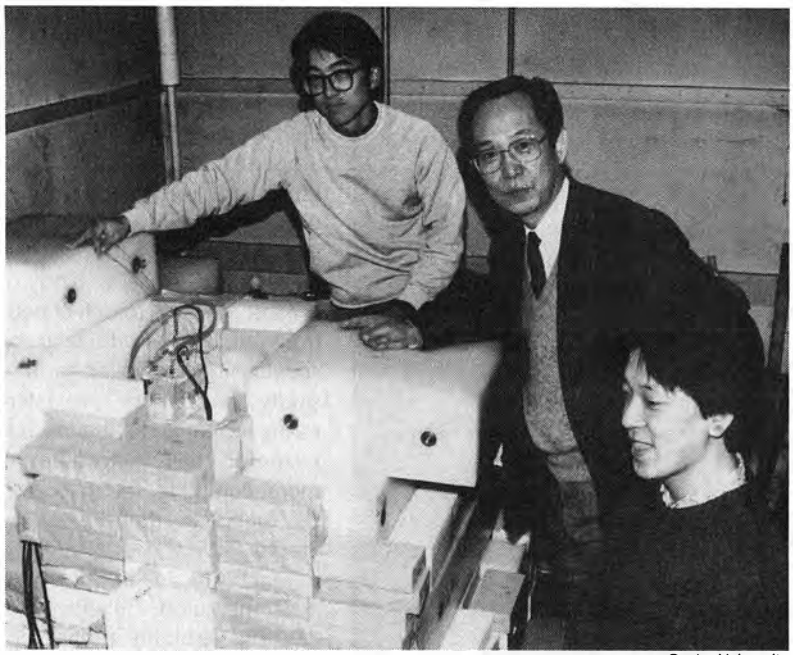
Most attempts to detect neutrons fail, thereby adding to the skepticism. However, a few studies noted here give interesting insight about the mechanism for their generation. A more complete summary can be found in the review by Storms.[125]

Takahashi et al.[32, 126, 127] measured the energy of neutrons emitted from electrolytic cells containing a palladium cathode subjected to alternate high and low applied current. Neutrons were seen at 2.54 MeV and between 3 and 7 MeV, suggesting a multi-body process for their production. This idea was further explored using ion bombardment.

Scaramuzzi and co-workers[128] reported neutron emission when titanium was temperature-cycled in D_2 gas. This observation prompted many attempts[129] to replicate the claim, with many being successful, but with many failures. Analysis after a similar study showed the presence of anomalous tritium.[130] Emission appeared to occur most often when titanium passed through a temperature associated with a phase change. Considerable cracking of the hydride occurred, but simple crack formation did not seem to relate to emission. Jones et al. have recently detected neutron emission from titanium after being loaded in D_2 or reacting with D_2SO_4, similar to the claims made by these workers in the past.[131]

Energetic Radiation

Occasionally, low-energy radiation detectors are placed on or near an active surface, either during or after the study. Evidence for low-energy X-rays of various frequencies is sometimes obtained.[132-144] When energy is measured, it can be sometimes attributed to characteristic K-alpha emission from atoms known to be present. Occasionally, the radiation appears to result from radioactive decay. Evidence for tightly focussed beams of radiation has been reported[106] from electrolytic cells, as well as during ion bombardment.[28] This behavior is important because it indicates that emitted radiation can be sensitive to the physical orientation of the source, much like a solid-state laser. Particle detectors, such as CR-39 plastic,[28, 145-155] placed near an active surface, show evidence for energetic alpha and proton parti-



Osaka University

Akito Takahashi and students with a cold fusion experiment at Osaka University, where Takahashi heads the Department of Nuclear Engineering. Polyethylene blocks are used to shield the sensitive neutron detector from background radiation. Takahashi visited the United States in April 1992 to meet with U.S. scientists and brief them in detail on his experimental method.

cle emission, as well as energetic electrons, although not all from the same sample.

Energy is being generated and released as electromagnetic radiation and particles, as expected, but this energy is too low to allow escape from the apparatus. This is a mixed blessing, because it allows studies to be made without danger of radiation exposure, but it makes this diagnostic tool more difficult to use. It also shows that all of the nuclear energy is not immediately communicated to the lattice, but is retained by some nuclear products.

Transmutation Products

Transmutation products consist of elements much heavier than hydrogen. These are detected using various methods, including neutron activation, XPS (X-ray photo-electron spectroscopy), EDX (energy dispersive X-ray analysis), and SIMS (secondary ion mass spectroscopy). Occasionally, sufficient material is produced to allow normal chemical analysis.

Most evidence is based on using the electrolytic or gas discharge methods, or a combination thereof. Unexpected elements seem to result from many kinds of reactions, including fusion between any hydrogen isotope and a heavy element, fusion between two different heavy elements, and fission of a heavy element. Abnormal isotopic ratios are frequently found. Only a few of the many reports are described here.

Miley et al.[59, 156] have studied this process in some detail, mainly using electrolysis of electrolytes based on H_2O. A spectrum of nuclear products is found, with high concentrations falling into four mass ranges of 20-30, 50-80, 110-130, and 190-210.[157] Mizuno et al.[158, 159] have also explored the subject in detail, mainly using electrolytes based on D_2O. Abnormal isotopic ratios of Hg, Fe, and Si were found. Although some minor elements might have resulted from contamination, it is very difficult to understand how major concentrations could come from this source, especially those having abnormal isotopic ratios.

Compounds dissolved in an electrolyte can deposit their positive constituent on a nickel cathode, where it has been found to be converted to another element. For example, when potassium compounds are used, calcium is formed when H_2O is present.[63, 160, 161] Other similar elements suffer the same fate in H_2O[162.163] Cathodes made from other metals produce a more complex result.[164]

A particularly compelling study was reported by Iwamura et al.[23] They deposited 40 nm of palladium on a layer of CaO, which had been deposited on bulk palladium. A small amount of cesium or strontium was applied to the surface by electrolysis. When deuterium gas was caused to diffuse through this sandwich, a reduction in the amount of initial element, and a growth of praesodymium or molybdenum, was observed by X-ray photoelectron spectroscopy. The molybdenum had an isotopic concentration like that of strontium, not like normal molybdenum. This work shows that transmutation reactions can occur by addition of 4 deuterons to the target nucleus as a single event. Why Pd was not transmuted needs to be explained.

Evidence for iron production during arcing between carbon electrodes under H_2O has been reported.[16, 165-167] This method seems to be easily reproduced. Palladium and gold cathodes also showed excessive iron after electrolysis in light water.[168, 169]

Radioactive isotopes, other than tritium, are seldom reported. When they are, their presence is difficult to reject, especially when their half-life is short. Bush and Eagleton[170] produced a mixture of radioactive isotopes with an average half-life of 3.8 days in an electrolytic cell. Mizuno et al.[159] found what appeared to be ^{197}Pt after electromigration of D_2 in a solid oxide. Notoya[62] found evidence for ^{24}Na in an electrolytic cell containing Na_2CO_3 and H_2O, using a nickel cathode. Gamma emitters were also found after ion bombardment.[171] Wolf[172] obtained a complex spectrum of gamma emissions after electrolyzing a cell containing D_2O with some aluminum, nickel, and boron present. It is safe to conclude that radioactive elements may have been produced in other studies as well, but were not detected for lack of trying.

One of the most surprising and difficult-to-explain observations involves transmutation reactions within living cells. Such claims were made decades ago,[173] but only recently have

the necessary careful measurements been done to give some credence to the claims. Vysotskii et al.[174] showed that ^{55}Mn is converted to ^{57}Fe when a bacteria is grown in D_2O containing $MnSO_4$. Other anomalous nuclear reactions were discovered during later work.[175] Komaki[53] demonstrated that several types of yeast and bacteria grown in normal water convert elements in their environment to the ones they need when the required elements are absent. This provides one more unusual environment that must be addressed by theory, and one more strange observation that tests the ability of the reader to remain open-minded.

4. The Nuclear-Active Environment

A number of observations place the nuclear-active environment in the surface region of a Pons-Fleischmann cathode. These are:

(1) Almost complete loss of helium to the gas.

(2) Appearance of tritium in the electrolyte rather than in evolving gas.

(3) Observed heat generated on the surface.

(4) Transmutation products located only in the surface region.

(5) Presence of melted regions on the surface.

(6) Ability to generate a large effect using thin deposits on an inert substrate.

Many careful analyses of such surfaces reveal a complex alloy containing lithium, platinum, elements provided by the Pyrex container, and impurities in the electrolyte, with much less or no palladium. In addition, measurements of the surface composition place it above D/Pd = 1.5, as can be seen in Figure 1, and perhaps as high as D/Pd = 2. As argued by Storms,[72] the nuclear-active environment is not pure β-PdD in an electrolytic cell, nor may this phase be involved at all. At the very least, the material contains a much higher deuterium content than previously thought, which allows for the presence of deuterium dimers.

Other materials, including titanium and aluminum, can support a nuclear-active environment. Loading of aluminum with deuterium, followed by electron bombardment, is found to produce anomalous nuclear emissions.[147] Even production of aluminum by electrolysis from cryolite appears to create tritium.[176] Titanium, when electrolyzed,[6] or when gas-loaded by D_2, produces evidence for nuclear events in the presence of nanocrystals.[177] Storms[18] incorporated fine powders of various materials, including TiO_2 and Cs_2O, into palladium films, and observed anomalous heat. Apparently, a great many compounds and structures can produce the nuclear-active environment, with little evidence for β-PdD being one of them.

On the other hand, palladium-black[21] and catalytic palladium[22] host the nuclear-active environment when exposed to modest pressures of deuterium. However, the impurity content, D/Pd ratio, and structure of these nanoparticles are not known. Until this information is available, the role of β-PdD is unknown, even in this form.

The only feature common to most, if not all, studies is the presence of nanosized particles when anomalous effects are observed. These structures are either provided initially, or they are generated *in situ* on a cathode surface by electrolytic action. Sputtering during ion bombardment can also generate them. Repeated loading and deloading of palladium[178] or nickel, will generate such structures as the material cracks. Energetic emissions are generated by this process.[143] Jiang et al.[179] suggest that the nuclear reactions occur at the tips of such structures. Until the exact nature of the nuclear-active environment is determined, reproduction of the effects will be controlled largely by chance, and explanations will have little relationship to reality.

5. Understanding How Palladium Behaves

Most metals react with the isotopes of hydrogen-forming compounds. These compounds are either ionic (like LiH), metallic (like PdH), or covalent (like CH_4). Ionic hydrides release hydrogen when exposed to water, while metallic hydrides are inert. Ionic hydrides contain hydrogen as a negative ion, while hydrogen is partially ionized to a positive ion in the metallic hydrides. Some elements, such as silver, gold, and platinum, form hydrides only at very high applied pressures. Nickel is difficult to hydride because a diffusion barrier of the hydride is formed on the surface. However, repeated cycling will eventually break up the structure and allow conversion. Palladium is not unique in its ease of hydride formation, nor in the amount of hydrogen it can contain compared to many known alloys.

When β-PdD is formed, the structure is cracked by the resulting large expansion,[180] causing many dislocations.[181] As a result, pre-annealing of palladium is expected to have little effect on the resulting PdD. These cracks are hard to notice, but critical in determining the loading limit.[182-184] Most elements, like uranium and titanium, turn to powder during the process, which renders them difficult to study in this context.

The properties of palladium hydride can be modified by alloy formation. Addition of silver prevents cracking, but reduces hydride stability. As a result, the same applied D_2 pressure produces a smaller D/(Pd+Ag) ratio. Alloying with lithium increases hydride stability. Both elements substitute for palladium and cause a reduction in lattice size. Addition of platinum has an effect similar to silver. Boron, which substitutes for deuterium, makes the hydride more stable, but can result in brittle material if the very stable boride is allowed to form in the grain boundaries.

5.1 Phase Diagram of the Pd-D System

Like the palladium-hydrogen system,[185-188] the palladium-deuterium system is known to contain two stable phases, an alpha phase created by deuterium randomly located between the palladium atoms (a typical solution), and a beta phase created by deuterium randomly located within a face-centered-cubic structure (a typical defect compound).[189] The lower phase boundary of this phase depends on applied D_2 pressure and temperature, as shown by Figure 3,[190] but is at $PdD_{0.7}$ under 1 atm D_2 and room temperature. Above about 275° C, the alpha and beta phases merge into a single-phase region when more than 35 atm of D_2 pressure is applied. Deuterium occupies equivalent random sub-lattice sites in β-PdD above about 50 K. Below 50 K, ordered occupation between the occupied and unoccupied sites occurs.[191, 192] The upper boundary is difficult to reach because very high applied pressure is required. Presumably, the beta phase can not exist above $PdD_{1.0}$. However, electrolytic action is able to generate sufficient chemical activity to drive the surface composition well above 1.0. But application of modest pressures to palladium having a particle size below 5 nm results in compositions near D/Pd = 2.0.[193, 194] One can only speculate about the resulting phase. However, other metals that form hydrides more stable than β-PdH, hence stable at accessible pressures, form compounds having limiting compositions of MH_2 and MH_3, some of which contain hydrogen dimers. Calculations indicate that dimers do not form in the β-PdH structure.[195] In other words, the tetrahedral sites are not occupied. No evidence exists for the proposed gamma phase.[196]

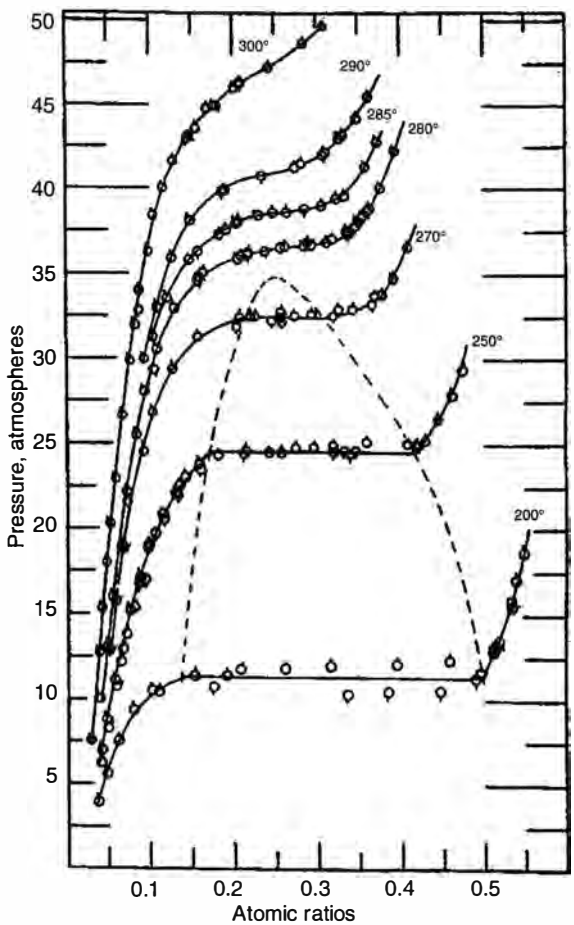


Figure 3
RELATIONSHIP BETWEEN PRESSURE AND COMPOSITION WITHIN THE PD-D SYSTEM AT VARIOUS TEMPERATURES
The α-phase is on the left and the β-phase is on the right. They come together as a single phase above about 275°C and 35 atm.

5.2. Structure and Lattice Dimensions

Both α-PdD and β-PdD are face-centered-cubic, with the latter having a NaCl-type structure. Position of D atoms in the α-phase is assumed to be the same as those in the β-phase, but with many fewer D atoms in these positions. However, location of the D atoms at a concentration available at room temperature has not yet been possible. Consequently, measurements were made at higher temperatures, where the solubility is greater. Deuterium is presumed to have the same position at lower temperatures.

Conversion of α-PdD to β-PdD results in a volume increase of about 10 percent, thereby accounting for the tendency to form cracks. The amount of crack formation can be deter-

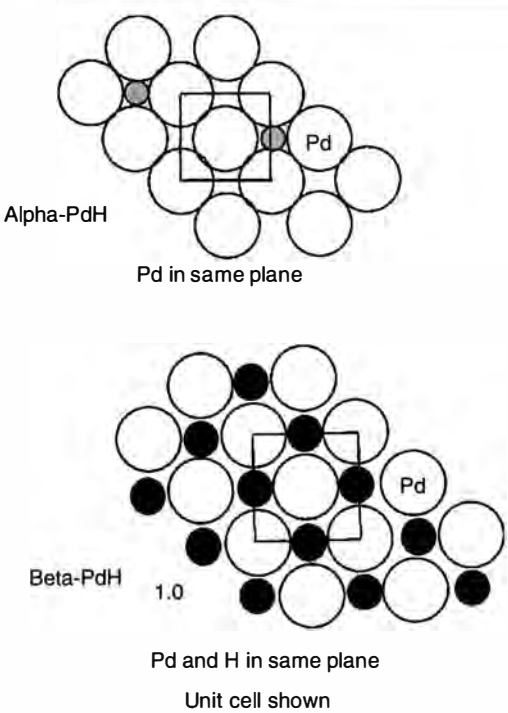


Figure 4
COMPARISON OF α-PdD AND β-PdD
The figures show the [100] Miller index faces of α-PdD and β-PdD. The next layer of atoms is applied to both the alpha-phase and beta-phase, with a shift of one-half unit cell.

mined by comparing the expected lattice volume, based on the composition, to the measured volume.[114] In forming the β-phase, atoms of Pd shift to allow D atoms into equivalent positions, as shown in Figure 4. Hydrogen lies in the plane, forcing Pd atoms further apart, and occupying the so-called octahedral position. These positions can be filled or empty in a random manner up to a completely filled lattice at $PdH_{1.0}$.

Because X-ray diffraction is insensitive to the position of hydrogen, X-ray patterns of the two phases appear to be identical, with only a shift in line position caused by different Pd atom spacing. Only neutron diffraction of Pd-D is able to determine the hydrogen position. A tetrahedral position is available, but neutron diffraction studies show that it is not occupied at compositions available to the studies.[197-199] The resistivity behavior leads to the same conclusion.[200] A study using low incident angle X-ray diffraction from an electrolyzing surface, shows no evidence for unusual close approach between deuterium atoms,[201] and no new phases have been detected up to $PdD_{0.9}$.[202] No evidence exists for tetrahedral occupancy, which is often assumed to be available.

Metastable structures have been obtained by quenching from 600°C while under high pressure,[203] and by bombarding thin films of Pd with protons at 600°C, followed by rapid cooling in H_2.[204, 205] Because these phases are metastable at room temperature, and form under conditions not present in cold fusion cells, they are expected to play no role in the cold fusion process.

The lattice parameter of β-PdD increases as additional lattice sites are occupied by deuterium. A value of 0.4025 nm is published for D/Pd = 0.61, which is the value for α-PdD in equilibrium with β-PdD at the lower phase-boundary of the beta phase. A value of 0.405 nm has been measured for $\beta\text{-}PdD_{0.77}$.[206] As many authors have pointed out, the distance between deuterium nuclei, even in $\beta\text{-}PdD_{1.0}$, is too great to allow fusion by a "normal" process.[207, 208] No knowledge exists about the structure or lattice size of phases above $\beta\text{-}PdD_{1.0}$, or of nanosized particles. In addition, no knowledge exists about the complex alloy phases that are actually on a cathode surface, and are expected to host the nuclear-active environment. Therefore, the effect of "normal" processes can not be evaluated.

5.3 Thermodynamic Properties

The thermodynamic properties of β-PdD are very similar to those of β-PdH, for which more data are available.[186, 209-211] The partial enthalpy of formation for deuterium is proposed to become less negative as D/Pd increases, going positive above about 0.85.[212, 213] This behavior does not mean that higher compositions can be achieved by simply increasing the temperature once $PdD_{0.85}$ has been exceeded.[7] This can not happen because the entropy also changes. As a result, the Gibbs energy of formation, which determines stability with respect to the gas phase, continues to show decreasing stability as temperature and composition increase. Hence, deuterium will be lost to a gas held at constant pressure as temperature is increased, regardless of the D/Pd ratio.

The following equation gives the D_2 pressure over β-PdD as a function of temperature and composition, where r = D/Pd ratio and T = °K:[189]

$$\ln P(D_2, \text{atm}) = 12.8 + 2\ln [r/(1-r)] - [11{,}490 - 10{,}830r]/T$$

The pressure within the α-β two-phase region is given by:

$$\ln P(D_2, \text{atm}) = -4{,}469/T + 11.78.$$

On the other hand, if a nuclear-active phase exists with a composition greater than $\beta\text{-}PdD_{1.0}$, it could become more stable with respect to β-PdD as temperature is increased, because of its greater entropy. This increased concentration would provide more sites in which nuclear reactions could occur, and could explain the positive effect of temperature. Of course, this ideal situation does not exist in the surface region, where the nuclear-active environment is proposed to occur, because a Pd-D phase in this region, if it exists at all, is highly contaminated by other elements. Nevertheless, the nuclear effects show a positive temperature effect.

5.4. Measurements of D/Pd ratio

The deuterium content has been measured using change in resistivity, change in weight, and production of orphaned oxygen. X-rays reflected off the surface have allowed measurement of the lattice parameter, which can be used to determine the composition. All of these methods, except perhaps the latter, measure an average composition of the sample, not the composition of the nuclear-active environment. Furthermore, this average will depend on the shape and size of the sample, and on the magnitude of the concentration gradient. Unfortunately, the reported values have only a general relationship to the composition of the nuclear-active environment.

Resistivity

Many studies use the resistivity of a palladium cathode to determine its D/Pd ratio. This method gives an average composition of the sample, and is influenced by many variables.[214, 215] Composition is calculated using the resistivity ratio of sample/pure Pd (R/Ro). The value goes from 1.0 at pure Pd to about 2.0 at the lower phase-boundary of the beta phase, with a linear relationship between these two end members. R/Ro decreases within the single-phase region to about 1.0 at the upper boundary, whereupon a change in slope is observed.[216] Resistivity behavior is different for thin films,[217, 218] depending on thickness below 100 nm. This will be especially true when a thin film of palladium is loaded by electrolysis, because the highly loaded surface region makes up such a large fraction of the total in such a sample. Therefore, the resulting resistivity will more closely represent properties of the surface rather than the interior. Therefore, values obtained from thin films can not be compared to those obtained from bulk material, where the value is determined mainly by the much lower interior composition.

Resistivity in the two-phase region between α-PdD and β-PdD should be a linear combination of values between the end members. However, because hysteresis effects occur in this composition region in the absence of equilibrium, the observed relationship may not be linear or reproducible. The maximum value for R/Ro at the low boundary of the beta phase is determined by the composition acquired by β-PdD. This composition is affected by temperature, pressure, and impurity content, hence does not have a unique value. However, for convenience, people use a complex polynumeral to define the behav-

ior between pure Pd and β-$PdD_{1.0}$, a method that may introduce significant error in the low composition region of the beta phase. Furthermore, once $PdD_{1.0}$ has been exceeded, the resistivity must assume a different behavior determined by another two-phase region. Consequently, the behavior can not be extrapolated beyond $PdD_{1.0}$.

Weight Change

When loaded to $PdD_{1.0}$, a 1g sample of Pd has increased in weight by 0.0185g. As a result, composition can be determined using a four-place balance. Because such samples deload rapidly, measurements must be made as a function of time, and extrapolated back to the time when electrolysis was stopped, using the square root of time.

Orphaned Oxygen

When D_2O is electrolytically decomposed and D_2 reacts with palladium, orphaned oxygen remains behind as a gas. The amount of this gas can be used to determine the amount of deuterium added to the cathode, provided a recombiner catalyst is present in the cell. This can be done by measuring the pressure increase in a sealed system, or by observing how much fluid is displaced from an external reservoir. The method, when calibrated after the study by measuring the weight change of the cathode, has the ability to measure D/Pd to ±0.005 during loading.

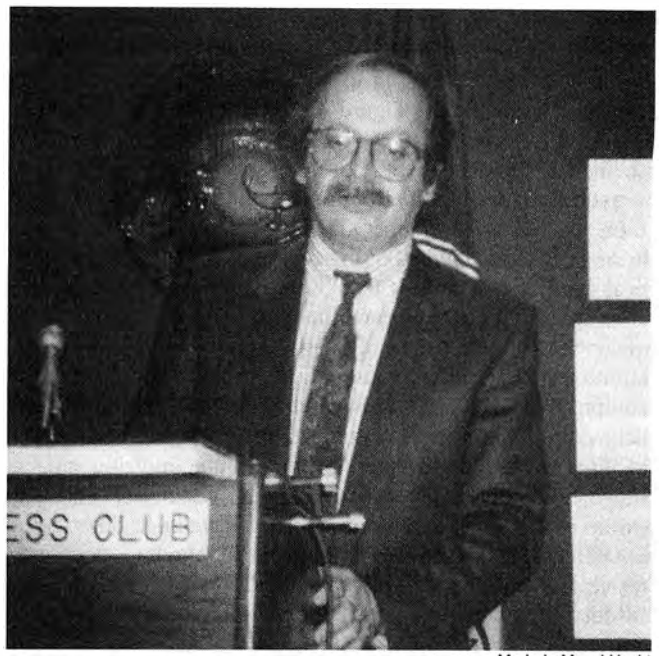
X-ray Lattice Parameter

This method is difficult to apply to conventional cells, but can be effective in measuring the near-surface composition when X-rays can be reflected from the surface.

6. How to Reproduce The Pons-Fleischmann Effect

Because so many methods have produced anomalous effects, a researcher wishing to replicate the cold fusion effect is faced with a dizzying array of choices, and must begin by choosing a method. He or she must also choose which anomalous effect—heat, tritium, helium, or transmutations—will be used to gauge success. Unfortunately, the methods of doing cold fusion and measuring success require skill, and measurement of the effects with confidence requires expensive instruments. Regardless of how simple the Pons-Fleischmann method looks, it is a complex and difficult experiment, not suited to the amateur.

Nevertheless, of the methods used, the Pons-Fleischmann Effect requires the least expense to investigate, although its replication is considered difficult. Detection of anomalous heat is the most cost-effective way to reveal anomalous behavior. However, if suitable tools are available, measurement of transmutation products on the cathode surface frequently produces fewer ambiguous results. Improved success is achieved when additional energy is added to the cathode in the form of plasma that is generated using pulsed high voltage or laser heating.



Marjorie Mazel Hecht

Giuliano Preparata, a physicist from the University of Milan (now deceased), was an early cold fusion experimenter in the electrodiffusion method. Here he is speaking at a March 27, 1992 press conference in Washington, D.C., sponsored by Cold Fusion Research Advocates. "We are witnessing the birth of a new physics here, but the scientific establishment behaves like a priestly caste that will not allow in any new ideas."

Past efforts to duplicate the Pons-Fleischmann Effect concentrated on the bulk properties of the palladium cathode.[219-221] Ways were found to reduce cracking and achieve a high average D/Pd ratio. Although these methods were sometimes successful, greater success can be achieved by concentrating on the nature of the deposited surface, regardless of what is used as the substrate. Palladium can be plated on clean platinum,[18] or on silver outside of the cell, or a suitable coating of palladium can be applied to an inert substrate *in situ* using an electrolyte containing $PdCl_2$ + LiCl.[222] This method has enjoyed frequent success. Celani et al.[223] have produced high compositions in thin films and fine wires of palladium using a very dilute electrolyte containing $SrCl_2$ + HCl + CO_2 and a small amount of $HgCl_2$.

Efforts must be made to insure that the electrolyte contains the correct impurities and does not contain "bad" impurities. The nature of "bad" impurities is not well understood, causing some batches of heavy water not to work, for unknown reasons. A new cell is best cleaned using a dummy cathode as a getter that is removed after several days of electrolysis, and replaced by a new cathode. If a suitable impurity layer is not applied outside of the cell, a layer of microcrystals must slowly form on the cathode surface during the study. When such a

layer is applied within a conventional Pons-Fleischmann cell, it consists mainly of lithium from the electrolyte, silicon from the Pyrex, and platinum from the anode. This deposition process will be very slow because platinum becomes available only as rapidly as black platinum oxide forms on, and dissolves off, the anode surface. This process is accelerated by the presence of Cl^- in the electrolyte. Pyrex slowly dissolves in the electrolyte, and this process is accelerated as the lithium content of the electrolyte is increased. As a result, considerable time must pass before success is achieved in a new cell. In fact, attempts to duplicate the effect using very pure materials contained in Teflon cells failed until Pyrex was added to the solution. Other chemicals can be added, such as aluminum[224] or thiourea,[225, 226] which will sometimes produce an active coating and/or higher composition more rapidly. With this new understanding, the challenge must focus on placing suitable materials in the electrolyte at a low concentration so that small crystals will grow on the surface. Too high a concentration of impurities within the electrolyte will not work, because the crystals will rapidly grow too large to be useful.

7. Theory of The Cold Fusion Effect

Hundreds of attempts have been made to explain the cold fusion effect. A broad range of possibilities has been explored, but with little success. So far, no theory has successfully shown how the effect can be amplified and made more reproducible, even though many suggestions have been made. This failure has resulted from an emphasis on the nuclear mechanism instead of considering the environment in which the reactions occur. The experimentalist has control only over the environment, with the nuclear mechanism occurring only after this environment has been created.

A successful theory must meet several basic challenges. First, a mechanism must be found to overcome the Coulomb barrier of hydrogen, as well as of elements having much larger barriers. Second, once nuclear energy is released, a mechanism must be found that can quickly degrade the energy to prevent emission of significant energetic radiation, which is not detected. Third, a unique environment must be identified, and shown how it influences the nuclear mechanism, especially how it determines which of the many possible nuclear reactions is catalyzed. Fourth, formation of helium without gamma emission needs to be explained. Most theories address only one, or at most two, of these challenges. Until a theory can show how the nuclear-active environment is created, and can describe its unique nature, little progress will be made, especially because most theories are based on the ideal properties of β-PdD. As explained in Section 4, the nuclear-active environment does not involve this compound under many conditions, if at all.

Role of Neutrons

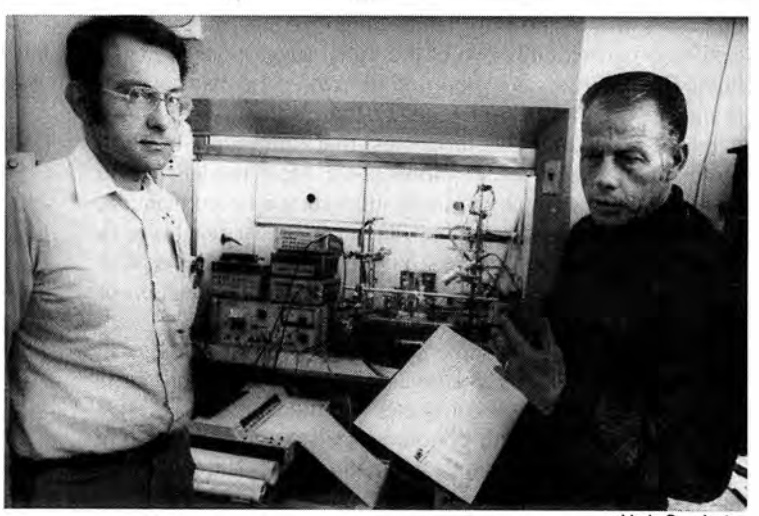
Obviously, if neutrons are involved in the nuclear mechanism, the Coulomb barrier would not be an issue. Therefore, many people have proposed a source of potentially reactive neutrons. A few of these theories are described here.

Kozima[227] has written a large number of papers based on the idea that neutrons are contained in normal materials in stabilized form. When proper conditions are created, that is, the nuclear-active environment, these structures become unstable and react with surrounding nuclei. He calculates the concentration of these "clusters," and uses the consistency of the resulting value as support for his idea.

Fisher[228] proposes that neutron clusters are lightly bonded to certain nuclei. When proper conditions are created, these clusters break up and react with other nuclei in the environment. Evidence for super-heavy carbon, presumably caused by an attached neutron cluster, has been reported by Oriani.[229]

Many people have observed that if the electron associated with hydrogen or deuterium could get sufficiently close to the nucleus, a virtual neutron or a dineutron would result. In this way, the electron might provide enough shielding for the proton or deuteron to enter a nucleus. Presumably, the electron would not have to actually create a real neutron, a process that requires energy and a neutrino. Mills[230] provides a theoretical basis for allowing the electron to closely approach the nucleus, with the formation of the so-called hydrino. Dufour[231] has made a similar suggestion. Both people have provided evidence for the shrunken hydrogen concept.

All theories based on real neutrons must explain how the nuclear-active environment releases the neutrons or causes their creation, and why so few neutrons escape from the active region, even though this region is too small to offer much



Linda Sappington

Melvin Miles (right) and Benjamin Bush, with their cold fusion experiment at the Research and Technology Division of the Naval Air Warfare Center at China Lake, Calif. in the early 1990s.

absorption. Formation of ^{4}He without ^{3}He or tritium production also needs to be addressed.

Role of Phonons

A phonon is a mythical particle used to describe energy contained in the vibration of atoms and electrons located within a material. These vibrations are proposed to cause a few atoms to approach one another within nuclear reaction distance,[232, 233] or to cause energy to accumulate within a nucleus[234] so that the nucleus becomes unstable. Once a nuclear reaction releases energy, phonons are proposed to communicate this energy to the lattice.[235] Besides the considerable challenge of showing that phonons have the necessary properties to do the proposed jobs, it is necessary to show why this only happens within the unique nuclear-active environment.

Role of Particle-Wave Conversion

The Chubbs[236] have proposed that the deuteron nucleus can, under proper conditions, convert to a wave. As such, it can interact with another deuteron wave without a Coulomb barrier being present. This interaction briefly forms a helium wave, which slowly converts to a helium particle by losing small quanta of energy to the surrounding lattice. This model solves a few problems, but it does not account for how transmutation products are produced, and what unique property of the lattice encourages this conversion. Simply having a periodic array of atoms is not sufficient, because this condition exists throughout the material, while nuclear reactions are localized in special regions.

Role of 'Strange' Particles

Explanations based on rare particles have been proposed. These include the Erzion,[237] the NATTOH,[238] fractionally charged particles,[239] massive negative particle,[240] and super-heavy nucleus.[241] How these particles are activated by, or impact on, the nuclear active environment is not clear.

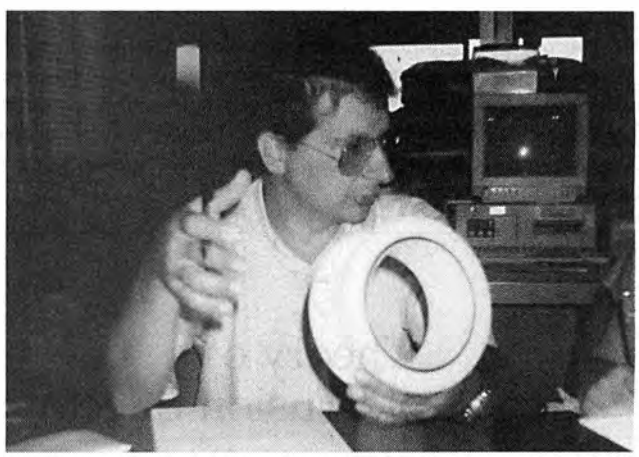
Role of Tunnelling or Enhanced Cross-Section

A number of authors have explored the possibility that processes within the PdD lattice might reduce the effective Coulomb barrier. Only two of the initial suggestions are cited here. The processes are proposed to involve mechanisms that bring the D atoms closer together than normal, using resonance effects,[242] or processes that introduce electron screening between the D atoms.[243] Most models fail to show what makes PdD unique in supporting a fusion reaction, and they do not address other kinds of nuclear reactions. In general, the proposed models have not been able to explain the rate of fusion required for anomalous heat production or heavy element transmutation.

Recently, a source of screening electrons has been suggested to exist between two materials having different work functions, the so-called swimming electron theory.[244-246] This model is consistent with conditions existing in the apparent nuclear-active environment, and addresses the formation of heavy elements.

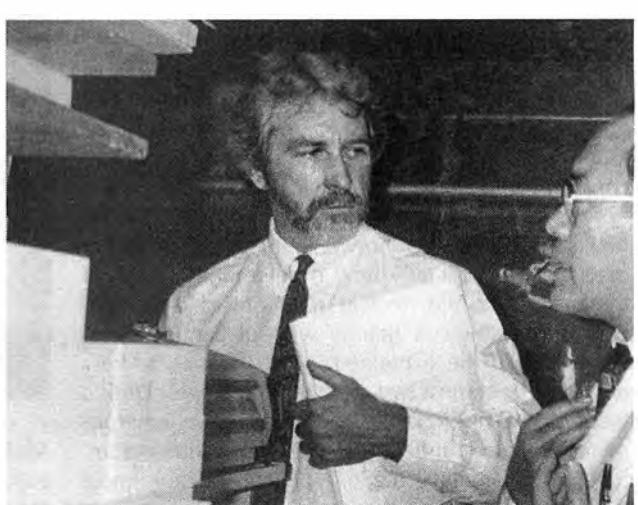
Role of Multi-Body Fusion

Multi-body fusion was first suggested by Takahashi et al.,[247] who arrived at this model using the energy spectrum of neutrons being emitted from an electrolytic cell. Later studies using ion bombardment are consistent with the model.[248] Recently, Iwamura et al.[23] show evidence for four deuterons entering a nucleus simultaneously, adding additional support to the multi-body model. Formation of such clusters,[249] followed by fusion within the cluster, solves many problems, not the least of which is a method to release momentum without emitting a gamma ray. In this case, energy is deposited in the lattice by energetic alpha particles and deuterons ejected from the cluster. The challenge for this model is to show how such clusters can form in a lattice, and the nature of such a lattice.



Carol White

Some of the scientists with successful cold fusion experiments: Above, Francesco Celani, ENEA, Italy; Below, Michael McKubre, Stanford Research Institute; Top row (p. 33), George Miley, University of Illinois; Tadahiko Mizuno, Hokkaido University; Middle row, Yoshiaka Arata and Yue-Chang Zhang, Osaka University; Bottom row, M. Srinivasan formerly Associate Director, Physics Group, Bhabha Atomic Research Center, India; and Eugene Mallove, founder of Infinite Energy *magazine, who was tragically murdered in May 2004.*

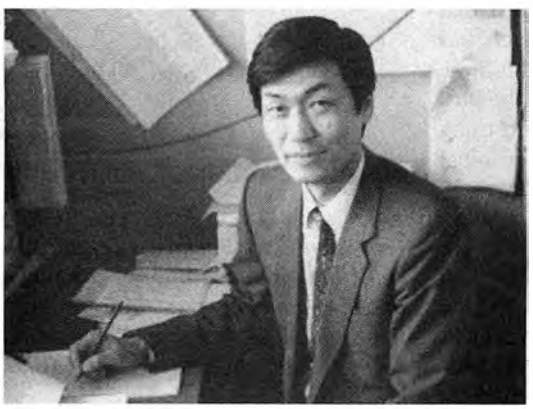


Carol White

8. Suggested Errors and Prosaic Explanations

Skeptics suggest that all cold fusion results are experimental error and instrument artifacts. To prove this hypothesis, they would have to examine each well-written, detailed cold fusion paper to find a set of errors that can explain away all observations. As difficult as it is to explain the nuclear reactions, finding such a comprehensive set of errors is even more difficult. Furthermore, it would call into question the validity of the experimental method itself. To reduce the challenge, most skeptics proposed an error that might occur in one study, and then assume it applies to all other studies. They do not try to examine each study, and they fail to realize that different instrument types and techniques are used that rule out the possibility of the proposed error occurring elsewhere. For example, skeptics often suggest that recombination may explain marginal excess heat in an open cell experiment, and then apply this critique to closed cells in which a recombination error is impossible.[250] Or they assume a prosaic process they can imagine to occur without offering any proof that the process actually occurs in nature. From a skeptic's point of view, the rules of evidence apply only to the person making a claim, with a suggested error requiring no justification whatever. While this approach is not very constructive, serious errors do occur in any experiment, and these need to be identified.

David Nagel



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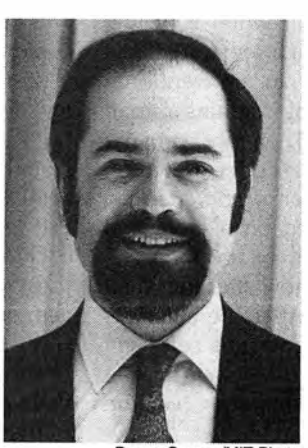


Donna Coveny/MIT Photo

A number of real errors have been identified; they are examined in detail below. Many more have been discussed by Storms.[71]

Temperature Gradients within an Isoperibolic Calorimeter

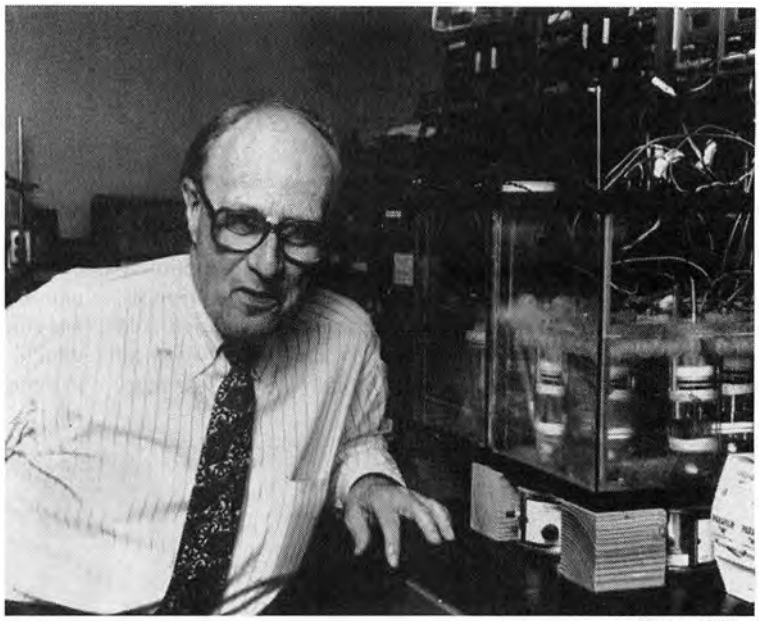
The first criticism of the Pons-Fleischmann heat measurement was based on a presumed artifact caused by temperature gradients within their isoperibolic cell.[251] Pons and Fleischmann showed that these were absent by moving their thermistor to different levels within the cell.[252] Nevertheless, this is a valid potential error.[67] Electrolytic stirring is seldom sufficient to completely remove the temperature gradient. Even mechanical stirring must be held very constant to achieve a stable measurement. Because of this potential error, most recent work uses either flow calorimetry or a Seebeck calorimeter, both of which do not suffer from this problem. A second-wall isoperibolic calorimeter has also been used with success.

Changes in Calibration Constant

All calorimeters must be calibrated. The resulting calibration constant may not always remain constant. Each time such a measurement is made, slightly different values are always obtained. If the claimed

anomalous energy is within the range defined by many calibrations, its reality can be questioned. Shanahan[253] argues that all claims for anomalous heat are caused by an unexpected change in the calibration constant because of some undefined process within the cell, but not by a nuclear reaction.

An answer to this challenge rests on three facts: (1) many reported values of anomalous heat are well outside of this range; (2) anomalous heat is frequently associated with universal patterns of behavior, as noted in Section 2; and (3) anomalous heat sometimes is associated with helium production or transmutation products, which are clear indicators of a nuclear reaction. Furthermore, a process that can produce such a change in all calorimeters has not been demonstrated, only suggested. At this time, if a person wants to reject anomalous heat, the proposed prosaic process must be demonstrated using as much rigor as was used in making the initial claim, not simply suggested.



Eugene Mallove

Prof. John O'M. Bockris at Texas A&M University, with a bank of fusion cells that produced tritium. A renowned electrochemist, Bockris came under tremendous pressure over his cold fusion work, including press libels and a petition from some fellow faculty members at Texas A&M requesting that his title of Distinguished Professor be revoked.

Tritium Contamination

When anomalous tritium was first claimed, it was rejected based on tritium being present in the environment, the cell materials, or in the palladium. All of these sources have been carefully analyzed and found to be free of sufficient tritium. At the present time, no plausible source has been found that explains all of the observations, other than its creation by a nuclear reaction.

Air Contamination in Helium

Early claims for helium production were rejected because of a presumed leak of air into the container. Since then, people have shown that air is absent by measuring the argon content at the same time as helium is measured. This eliminates this possibility. While this is a difficult measurement, requiring a complex instrument, the growing number of measurements showing a relationship between helium and energy makes a rejection of this relationship increasingly implausible.

Heavy Element Contamination

Detection of stable elements is difficult when very low concentrations are present, although such measurements are seldom questioned when applied to conventional research. In addition, practically everything contains a small amount of most other stable elements. Therefore, proving that a particular element, after having been concentrated on a cathode by electrolysis, has a nuclear origin, can be tricky. A plausible claim is usually based on a large and unexplained concentration being present, or an abnormal isotopic ratio. Some work even shows how the abnormal element increases with time. Clearly, most stable elements found on a cathode are not abnormal. However a sufficient number of observations for the presence of anomalous elements has been reported to make the transmutation reaction worthy of study.

9. New Insights and The Future Path

The following are proposed as new insights provided by recent observations described in this paper:

(1) Pure β-PdD, regardless of its deuterium content, is not the environment in which LENR occurs during the Pons-Fleischmann effect. Instead, the environment is a complex alloy containing an unknown combination of deuterium, palladium, platinum, lithium, and perhaps boron and silicon. This complex alloy apparently requires a very high deuterium content for the process to occur.

(2) Nearly pure β-PdD appears to be active at a relatively low deuterium content, when pure D_2 gas is applied.

(3) LENR requires nanosized particles of various complex materials, including living cells.

(4) All isotopes of hydrogen can be involved in LENR.

(5) Clusters of hydrogen isotopes form and interact with each other and with nearby nuclei to cause LENR.

(6) Many elements can enter into LENR, either with hydrogen, or with each other.

(7) The nuclear effects can be initiated by applying energy in various forms, including laser and microwave radiation of various wavelengths.

These conclusions are significantly different from conven-

tional thinking in the field, and well outside of what conventional physics can explain. Hopefully, rather than being rejected, these aspects of the phenomenon will be considered when new experiments and explanations are attempted. So far, present experiments and theories have not been very successful, so a person has little to lose by considering these possibilities.

Science has been successful because certain rules of evidence were adopted centuries ago, the so-called Scientific Method. These rules require that many people using different devices duplicate all novel observations. Such replications reduce the human tendency to deceive and to be deceived. In addition, the behavior observed in these various studies must show similar patterns, that is, important variables must have the same effect in all studies, regardless of the equipment used. Having an explanation for the strange behavior is *not* initially necessary, although eventual discovery of an explanation is important. This is a good method, and has served mankind well when it is faithfully applied. Science fails when these rules are ignored. They can be ignored several different ways, the most obvious being premature acceptance. Some scientists think this rule so important that they base their careers on protecting science from such a violation. A less obvious problem occurs when repeated replications are ignored because a scientist does not *want* to believe a result that conflicts with a favorite theory. Initially, cold fusion was rejected for the former reason. Now, rejection is based on the

DOE Panel Lukewarm on Cold Fusion

The U.S. government has once again made an effort to evaluate the reality of the phenomenon called cold fusion. The first effort was made in 1989 by the ERAB Panel (Energy Research Advisory Board) shortly after Profs. Fleischmann and Pons announced their discovery. The result was a mixed message in which no support for the claims was provided. Nevertheless, an implication was made to evaluate proposals by the normal peer review process. None was funded by the Department of Energy (DOE). Now, a new evaluation has been undertaken by a panel of reviewers assembled by the DOE, mainly from the physics profession.

The DOE Review Panel was provided with written documents chosen or written largely by Michael McKubre (SRI) and Peter Hagelsein (MIT). In addition, oral presentations were made to 11 of the 18 panel members by M. McKubre, P. Hagelstein, S. Jones, A. Lipson, G. Hubler, and V. Violante, at a meeting in Washington, D.C., held on Aug. 23, 2004. The panel was then asked to address the following charges:

(1) Evaluate the experimental evidence presented for the occurrences of nuclear reactions in condensed matter at low energies (less than a few electron volts).

(2) Determine whether the evidence is sufficiently conclusive to demonstrate that such nuclear reactions occur.

(3) Determine whether there is a scientific case for continued efforts in these studies and, if so, to identify the most promising areas to be pursued.

After a suitable delay, each reviewer submitted a written response. These documents can be found at www.LENR-CANR.org along with a response (by this author) to the reviewers' comments. The latter response is an effort to correct some of the misunderstanding and confusion shared by many reviewers.

A summary conclusion was made public by the DOE in which no support for the claims of nuclear reactions was provided, no special funding for the subject was authorized, but the suggestion was made for people to submit focussed proposals for a normal peer review process. In other words, the official attitude had not changed, even though the subject had been studied for 15 years by laboratories all over the world and after numerous papers supporting the claims had been published.

Popular Myth vs. Reality

In spite of the lukewarm summary, a majority of reviewers found reasons to believe some of claims, even though a few rejected the whole idea. At the other extreme, many reviewers even thought special attention should be directed toward investigating certain aspects of the phenomenon. Most reviewers were clearly distracted by the popular myth that the claims have not been replicated, are easily explained by error, and are in conflict with current theory. Nevertheless, many acknowledged that something very strange is being observed.

If fault is to be assigned, the popular and scientific press need to be criticized for their failure to properly inform the public about the reality of the claims. This failure has created a poorly informed peer group that can not objectively evaluate the subject, and a general population that is being denied the potential benefits from a pollution-free and inexpensive energy source.

The reality is no longer obscured by obvious questions of error or by incomplete studies. Work is now being done in at least eight countries, in major laboratories, by hundreds of trained scientists. Books are available describing the scientific and social history of the field (*Excess Heat: Why Cold Fusion Research Prevailed,* by Charles Beaudette, and *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy* by Steven Krivit and Nadine Winocur). A website (www.LENR-CANR.org) can be accessed, on which all of the facts are available.

No excuse remains for reporters or journal editors to continue the false myth. Even though the exact nature of the phenomenon is still not understood, it is clear that something very strange and new has been discovered. The only issue that remains is, who and which country will unlock the secret and make cold fusion energy available to a grateful world.

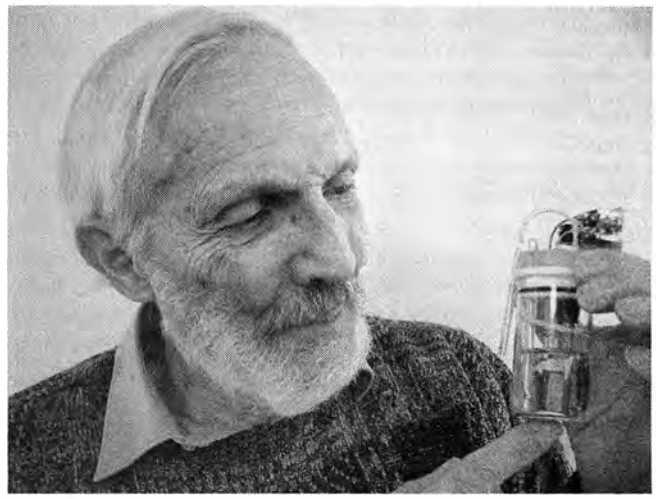
—Edmund Storms

latter. The first rejection was valid and consistent with the Scientific Method. The present rejection is not.

Skepticism, when carried to extreme, is as damaging as naive acceptance. At the present time, many people respect the skeptic for guarding the high ideals of science. In fact, skeptics frequently stop important progress, stifle originality, and turn creative people away from science altogether. Although many examples of this injury can be cited from the past, and especially from the present time, this rejection of cold fusion is particularly egregious because of its vehement nature and the importance of the discovery.

I ask you, the reader, to use good judgment and a responsible attitude in evaluating the incredible claims described in this Guide. Remember that new and strange claims do not have to be blindly accepted or blindly rejected, just explored with an open mind. Important new ideas almost always conflict with conventional understanding, so such conflict should not be used as a basis for outright rejection, before the possibilities have been carefully examined.

Dr. Storms retired as a radiochemist from Los Alamos National Laboratory 13 years ago.



The author with one of his working cold fusion cells: "Important new ideas almost always conflict with conventional understanding."

Notes

1. Beaudette, C.G., *Excess Heat. Why Cold Fusion Research Prevailed,* (Concord, N.H.: Oak Grove Press, *Infinite Energy* Distributor, 2000).
2. Fleischmann, M., S. Pons, and M. Hawkins, "Electrochemically Induced Nuclear Fusion of Deuterium," *J. Electroanal. Chem.,* 1989, Vol. 261, p. 301 and errata in Vol. 263.
3. Bush, R.T. and R.D. Eagleton, "Calorimetric Studies for Several Light Water Electrolytic Cells With Nickel Fibrex Cathodes and Electrolytes with Alkali Salts of Potassium, Rubidium, and Cesium," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
4. Mills, R.L. and P. Kneizys, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion," *Fusion Technol.,* 1991, Vol. 20, p. 65.
5. Storms, E., "Excess Power Production from Platinum Cathodes Using the Pons-Fleischmann Effect," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna).
6. Warner, J., J. Dash, and S. Frantz. "Electrolysis of D_2O with Titanium Cathodes: Enhancment of Excess Heat and Further Evidence of Possible Transmutation," in *Ninth International Conference on Cold Fusion, 2002* (Beijing: Tsinghua University, unpublished).
7. Fleischmann, M. "More About Positive Feedback; More About Boiling," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
8. Lonchampt, G., L. Bonnetain, and P. Hieter, "Reproduction of Fleischmann and Pons Experiments," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology).
9. Mengoli, G., et al., "Calorimetry Close to the Boiling Temperature of the D_2O/Pd Electrolytic System," *J. Electroanal. Chem.,* 1998, Vol. 444, p. 155.
10. Bockris, J., et al. "Triggering of Heat and Sub-Surface Changes in Pd-D Systems," in *Fourth International Conference on Cold Fusion, 1994* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
11. Castellano, et al., "Nuclear Transmutation in Deuterated Pd Films Irradiated by an UV Laser," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
12. Di Giulio, M., et al., "Analysis of Nuclear Transmutations Observed in D- and H-Loaded Films," *J. Hydrogen Eng.,* 2002, Vol. 27, p. 527.
13. Nassisi, V., "Transmutation of Elements in Saturated Palladium Hydrides by an XeCl Excimer Laser," *Fusion Technol.,* 1998, Vol. 33, p. 468.
14. Mizuno, T., et al.,"Production of Heat During Plasma Electrolysis," *Jpn. J. Appl. Phys. A,* 2000, Vol. 39, p. 6055.
15. Ohmori, T., "Recent Development in Solid State Nuclear Transmutation Occurring by the Electrolysis," *Curr. Topics Electrochem.,* 2000, Vol. 7, p. 101.
16. Sundaresan, R. and J. Bockris, "Anomalous Reactions During Arcing Between Carbon Rods in Water," *Fusion Technol.,* 1994, Vol. 26, p. 261.
17. Miley, G.H., et al., "Advances in Thin-Film Electrode Experiments," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
18. Storms, E., "Ways to Initiate a Nuclear Reaction in Solid Environments," *Infinite Energy,* 2002, Vol. 8(45), p. 45.
19. Miles, M., et al., "Thermal Behavior of Polarized Pd/D Electrodes Prepared by Co-Deposition," in *Ninth International Conference on Cold Fusion, 2002* (Beijing, China: Tsinghua University, unpublished).
20. Szpak, S., et al., "On the Behavior of the Pd/D System: Evidence for Tritium Production," *Fusion Technol.,* 1998, Vol. 33, p. 38.
21. Arata, Y. and Y.C. Zhang, "Definite Difference Among DS-D_2O, DS-H_2O, and Bulk-D_2O Cells in the Deuterization and Deuterium-Reaction," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
22. Case, L.C., "Catalytic Fusion of Deuterium into Helium-4," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
23. Iwamura, Y., M. Sakano, and T. Itoh, "Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation," *Jpn. J. Appl. Phys. A,* 2002, Vol. 41, p. 4642.
24. Claytor, T.N., et al., "Tritium Production from Palladium Alloys," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
25. Dufour, J., et al., "Interaction of Palladium/Hydrogen and Palladium/Deuterium to Measure the Excess Energy per Atom for Each Isotope," *Fusion Technol.,* 1997, Vol. 31, p. 198.
26. Bae, Y.K., D.D. Lorents, and S.E. Young, "Experimental Confirmation of Cluster-Impact Fusion," *Phys. Rev. A: At. Mol. Opt. Phys.,* 1991, Vol. 44, p. R4091.
27. Cecil, F.E. and G.M. Hale, "Measurement of D-D and D-^{6}Li Nuclear Reactions at Very Low Energies," in *Second Annual Conference on Cold Fusion, The Science of Cold Fusion, 1991* (Como, Italy: Societa Italiana di Fisica, Bologna, Italy).
28. Karabut, A. "Analysis of Experimental Results on Excess Heat Power Production, Impurity Nuclides Yield in the Cathode Material and Penetrating Radiation in Experiments with High-Current Glow Discharge," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
29. Kasagi, J., et al., "Observation of High Energy Protons Emitted in the TiDx+D Reaction at E_d = 150 keV and Anomalous Concentration of ^{3}He," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya, Japan: Universal Academy Press, Inc., Tokyo, Japan).
30. Kosyakhkov, A.A., et al., "Neutron Yield in the Deuterium Ion

Implantation into Titanium," *Fiz. Tverd. Tela,* 1990. Vol. 32, p. 3672 (in Russian).

31. Savvatimova, I., "Reproducibility of Experiments in Glow Discharge and Processes Accompanying Deuterium Ions Bombardment," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
32. Takahashi, A., et al., "Detection of Three-Body Deuteron Fusion in Titanium Deuteride under the Stimulation by a Deuteron Beam," *Phys. Lett. A,* 1999, Vol. 255, p. 89.
33. Wang, T., et al., "Investigating the Unknown Nuclear Reaction in a Low-Energy ($E < 300$ keV) $p + T_2Hx$ Experiment," *Fusion Technol.,* 2000, Vol. 37, p. 146.
34. Yuki, H., et al., "Measurement of the D(d,p) Reaction in Ti for 2.5 $E_d < 6.5$ keV and Electron Screening in Metal," *J. Phys. Soc. Japan,* 1997, Vol. 66, p. 73.
35. Beuhler, R.J., et al., "Deuteron-Deuteron Fusion by Impact of Heavy-Water Clusters on Deuterated Surfaces," *J. Phys. Chem.,* 1991, Vol. 94, p. 7665.
36. Mizuno, T., et al., "Anomalous Heat Evolution from a Solid-state Electrolyte under Alternating Current in High-temperature D_2 Gas," *Fusion Technol.,* 1996, Vol. 29, p. 385.
37. Oriani, R.A., "An Investigation of Anomalous Thermal Power Generation from a Proton-Conducting Oxide," *Fusion Technol.,* 1996, Vol. 30, p. 281.
38. Botta, E., et al., "Search for ^{4}He Production from Pd/D_2 Systems in Gas Phase," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
39. Iazzi, F., et al., "Correlated Measurements of D_2 Loading and ^{4}He Production in Pd Lattice," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
40. Celani, F., et al., "The Effect of Gamma-Beta Phase on H(D)/Pd Overloading," in *Seventh International Conference on Cold Fusion 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
41. Manduchi, C., et al., "Electric-field Effects on the Neutron Emission from Pd Deuteride samples," *Nuovo Cimento Soc. Ital. Fis. A,* 1995, Vol. 108, p. 1187.
42. Rajan, K.G., et al., "Electromigration Approach to Verify Cold Fusion Effects," *Fusion Technol.,* 1991, Vol. 20, p. 100.
43. Jorne, J., "Ultrasonic Irradiation of Deuterium-Loaded Palladium Particles Suspended in Heavy Water," *Fusion Technol.,* 1996, Vol. 29, p. 83.
44. Stringham, R., et al., "Predictable and Reproducible Heat," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
45. Lipson, A.G., et al., "Initiation of Nuclear Fusion by Cavitation Action on Deuterium-Containing Media," *Zh. Tekh. Fiz.,* 1992, Vol. 62(12), p. 121 (in Russian).
46. Griggs, J.L., "A Brief Introduction to the Hydrosonic Pump and the Associated 'Excess Energy' Phenomenon," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
47. Karpov, S.Y., et al., "On the Possibility of a Mechanism of Cold Nuclear Fusion," *Pis'ma Zh. Tekh. Fiz.,* 1990, Vol. 16(5), p. 91 (in Russian).
48. Arzhannikov, A.V. and G.Y. Kezerashvili, "First Observation of Neutron Emission from Chemical Reactions," *Phys. Lett.,* 1991, Vol. 156(A), p. 514.
49. Beltyukov, I.L., et al., "Laser-Induced Cold Nuclear Fusion in Ti-H_2-D_2-T_2 Compositions," *Fusion Technol.,* 1991, Vol. 20, p. 234.
50. De Ninno, A., et al., "Emission of Neutrons as a Consequence of Titanium-Deuterium Interaction," *Nuovo Cimento Soc. Ital. Fis. A,* 1989, Vol. 101, p. 841.
51. Menlove, H.O., et al., "The Measurement of Neutron Emission from Ti Plus D_2 Gas," *J. Fusion Energy,* 1990, Vol. 9, p. 215.
52. Vysotskii, V., et al., "Experimental Observation and Study of Controlled Transmutation of Intermediate Mass Isotopes in Growing Biological Cultures," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
53. Komaki, H., "Observations on the Biological Cold Fusion or the Biological Transformation of Elements," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya, Japan: Universal Academy Press, Inc., Tokyo, Japan).
54. Kervran, C.L., *Biological Transmutation,* (Beekman Publishers, Inc., 1980).
55. Campari, E.G., et al., "Ni-H Systems," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
56. Sankaranarayanan, T.K., et al., "Evidence for Tritium Generation in Self-Heated Nickel Wires Subjected to Hydrogen Gas Absorption/Desorption Cycles," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
57. Bush, R.T. and R.D. Eagleton, "Evidence for Electrolytically Induced Transmutation and Radioactivity Correlated with Excess Heat in Electrolytic Cells with Light Water Rubidium Salt Electrolytes," *Trans. Fusion Technol.,* 1994, Vol. 26(4T), p. 334.
58. Lonchampt, G., et al., "Excess Heat Measurement with Patterson Type Cells," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
59. Miley, G.H., "On the Reaction Product and Heat Correlation for LENRs," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
60. Niedra, J.M. and I.T. Myers, "Replication of the Apparent Excess Heat Effect in Light Water-Potassium Carbonate-Nickel-Electrolytic Cell," *Infinite Energy,* 1996, Vol. 2(7), p. 62.
61. Noninski, V.C., "Excess Heat During the Electrolysis of a Light Water Solution of K_2CO_3 with a Nickel Cathode," *Fusion Technol.,* 1992, Vol. 21, p. 163.
62. Notoya, R., "Nuclear Products of Cold Fusion Caused by Electrolysis in Alkali Metallic Ions Solutions," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
63. Ohmori, T. and M. Enyo, "Excess Heat Evolution During Electrolysis of H_2O with Nickel, Gold, Silver, and Tin Cathodes," *Fusion Technol.,* 1993, Vol. 24, p. 293.
64. Rothwell, J., "CETI's 1 Kilowatt Cold Fusion Device Demonstrated," *Infinite Energy,* 1996, Vol. 1(5&6), p. 18.
65. Swartz, M.R., "Optimal Operating Point Characteristics of Nickel Light Water Experiments," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
66. Reifenschweiler, O., "Some Experiments on the Decrease of Tritium Radioactivity," *Fusion Technol.,* 1996, Vol. 30, p. 261.
67. Storms, E., "Description of a Dual Calorimeter," *Infinite Energy,* 2000, Vol. 6(34), p. 22.
68. Miles, M. and K.B. Johnson, "Improved, Open Cell, Heat Conduction, Isoperibolic Calorimetry," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
69. Belzner, A., et al., "Two Fast Mixed-Conductor Systems: Deuterium and Hydrogen in Palladium-Thermal Measurements and Experimental Considerations," *J. Fusion Energy,* 1990, Vol. 9(2), p. 219.
70. Hansen, W.N. and M.E. Melich, "Pd/D Calorimetry—The Key to the F/P Effect and a Challenge to Science," *Trans. Fusion Technol.,* 1994, Vol. 26(4T), p. 355.
71. Storms, E., *Cold Fusion: An Objective Assessment,* 2001.
72. Storms, E., "The Nature of the Nuclear-Active-Environment Required for Low Energy Nuclear Reactions," *Infinite Energy,* 2002, Vol. 8(45), p. 32.
73. Oya, Y., et al., "Material Conditions to Replicate the Generation of Excess Energy and the Emission of Excess Neutrons," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
74. Storms, E., "My Life with Cold Fusion as a Reluctant Mistress," *Infinite Energy,* 1999, Vol. 4(24), p. 42.
75. Miles, M., K.B. Johnson, and M.A. Imam, "Heat and Helium Measurements Using Palladium and Palladium Alloys in Heavy Water," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
76. Storms, E., "A Critical Evaluation of the Pons-Fleischmann Effect: Part 1," *Infinite Energy,* 2000, Vol. 6(31), p. 10.
77. Miles, M., M. Fleischmann, and M.A. Imam, "Calorimetric Analysis of a Heavy Water Electrolysis Experiment Using a Pd-B Alloy Cathode," Washington: 2001, p. 154.
78. Arata, Y. and Y.C. Zhang, "A New Energy Caused by 'Spillover-Deuterium,' " *Proc. Jpn. Acad., Ser. B,* 1994, Vol. 70, p. 106.
79. McKubre, M.C.H., et al., "The Emergence of a Coherent Explanation for Anomalies Observed in D/Pd and H/Pd System: Evidence for ^{4}He and ^{3}He Production," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).

80. Clarke, B.W., et al., "Search for ^{3}He and ^{4}He in Arata-Style Palladium Cathodes II: Evidence for Tritium Production," *Fusion Sci. & Technol.,* 2001, Vol. 40, p. 152.
81. Iwamura, Y., et al., "Detection of Anomalous Elements, X-ray and Excess Heat Induced by Continous Diffusion of Deuterium Through Multi-Layer Cathode (Pd/CaO/Pd)," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
82. Wipf, H. and V. Erckman, "On Permeation Techniques for Electrotransport Studies on Metal-Hydrogen Systems," *Scr. Metall.,* 1976, Vol. 10, p. 813.
83. Tamaki, M. and K. Tasaka, "Field Formation of the Condensed Matter Fusion by Electro-Transport of Deuterium in Palladium," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya, Japan: Universal Academy Press, Inc., Tokyo, Japan).
84. Wisniewski, R. and A.J. Rostocki, "Hall Effect in the Pd-H System," *Phys. Rev. B: Mater. Phys.,* 1971, Vol. 3(2), p. 251.
85. Tsuchida, T., "Role of Hydrogen Atoms in Palladium," *J. Phys. Soc. Japan,* 1963, Vol. 18, p. 1016.
86. Bartolomeo, C., et al., "Alfred Coehn and After: The Alpha, Beta and Gamma of the Palladium-Hydrogen System," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
87. Del Giudice, E., et al., "The Fleischmann-Pons Effect in a Novel Electrolytic Configuration," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
88. Celani, F., et al., "Deuterium Overloading of Palladium Wires by Means of High Power Microsecond Pulsed Electrolysis and Electromigration: Suggestions of a 'Phase Transition' and Related Excess Heat," *Phys. Lett. A,* 1996, Vol. 214, p. 1.
89. McKubre, M.C.H., "Closing Comments Summarizing the Status and Progress of Experimental Studies," in *Ninth International Conference on Cold Fusion, 2002* (Beijing, China: Tsinghua University, unpublished).
90. Stringham, R. and R. George, "Cavitation Induced Micro-Fusion Solid State Production of Heat, ^{3}He, and ^{4}He," 1995.
91. Lipson, A.G., et al., "Observation of Neutrons from Cavitation Action on Substances Containing Deuterium," *Pis'ma Zh. Teor. Fiz.,* 1990, Vol. 16(9), p. 89 (in Russian).
92. Taleyarkhan, R.P., et al., "Evidence for Nuclear Emissions During Acoustic Cavitation," *Science,* 2002, Vol. 295: p. 1868.
93. Mallove, E., "Excess Heat in Cavitation Devices: World-Wide Testing Reports, *Infinite Energy,* 1995, Vol. 1(3), p. 16.
94. Kim, Y.E., "Cross Section for Cold Deuterium-Deuterium Fusion," *Fusion Technol.,* 1990, Vol. 17, p. 507.
95. Kasagi, J., et al., "Low Energy Nuclear Fusion Reactions in Solids," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
96. Cedzynska, K. and F.G. Will, "Closed-System Analysis of Tritium in Palladium," *Fusion Technol.,* 1992, 22, p. 156.
97. Taubes, G., "Cold Fusion Conundrum at Texas A & M," *Science,* 1990, Vol. 248, p. 1299.
98. Anderson, J., et al., "Letters and Response about Cold Fusion at Texas A&M, *Science,* 1990, Vol. 249, pp. 463-465.
99. Preparata, G., "A New Look at Solid-State Fractures, Particle Emission and 'Cold' Nuclear Fusion," *Nuovo Cimento Soc. Ital. Fis. A,* 1991, Vol. 104, p. 1259.
100. Yasui, K., Fractofusion Mechanism," *Fusion Technol.,* 1992, Vol. 22, p. 400.
101. Takeda, T. and T. Takizuka, "Fractofusion Mechanism," *J. Phys. Soc. Japan,* 1989, Vol. 58(9), p. 3073.
102. Camp, W.J., "Helium Detrapping and Release from Metal Tritides," *J. Vac. Sci. Technol. A,* 1977, Vol. 14, p. 514.
103. Storms, E., "A Review of the Cold Fusion Effect," *J. Sci. Expl.,* 1996, Vol. 10(2), p. 185.
104. Karabut, A.B., Y.R. Kucherov, and I.B. Savvatimova, "Nuclear Product Ratio for Glow Discharge in Deuterium," *Phys. Lett. A,* 1992, Vol. 170, p. 265.
105. Miles, M., B.F. Bush, and J.J. Lagowski, "Anomalous Effects Involving Excess Power, Radiation, and Helium Production During D_2O Electrolysis Using Palladium Cathodes," *Fusion Technol.,* 1994, Vol. 25, p. 478.
106. Gozzi, D., et al., X-ray, Heat Excess and ^{4}He in the D/Pd System. *J. Electroanal. Chem.,* 1998. 452, p. 251.
107. Bush, B.F. and J.J. Lagowski, "Methods of Generating Excess Heat with the Pons and Fleischmann Effect: Rigorous and Cost Effective Calorimetry, Nuclear Products Analysis of the Cathode and Helium Analysis," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
108. Isobe, Y., et al., "Search for Coherent Deuteron Fusion by Beam and Electrolysis Experiments," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
109. Arata, Y. and Y.C. Zhang, "Helium (^{4}He, ^{3}He) within Deuterated Pd-Black," *Proc. Jpn. Acad., Ser. B,* 1997, Vol. 73, p. 1.
110. Jordan, K.C., B.C. Blanke, and W.A. Dudley, "Half-Life of Tritium," *J. Inorg. Nucl. Chem.,* 1967, Vol. 29, p. 2129.
111. Corrigan, D.A. and E.W. Schneider, "Tritium Separation Effects during Heavy Water Electrolysis: Implications for Reported Observations of Cold Fusion," *J. Electroanal. Chem.,* 1990, Vol. 281, p. 305.
112. Boucher, G.R., F.E. Collins, and R.L. Matlock, "Separation Factors for Hydrogen Isotopes on Palladium," *Fusion Technol.,* 1993, Vol. 24, p. 200.
113. Will, F.G., K. Cedzynska, and D.C. Linton, "Reproducible Tritium Generation in Electrochemical Cells Employing Palladium Cathodes with High Deuterium Loading," *J. Electroanal. Chem.,* 1993, Vol. 360, p. 161.
114. Storms, E. and C. Talcott-Storms, "The Effect of Hydriding on the Physical Structure of Palladium and on the Release of Contained Tritium," *Fusion Technol.,* 1991, Vol. 20, p. 246.
115. Matsumoto, O., et al., "Tritium Production Rate," in *Anomalous Nuclear Effects in Deuterium/Solid Systems, AIP Conference Proceedings 228, 1990* (Brigham Young Univ., Provo, Utah: American Institute of Physics, New York).
116. Storms, E. and C.L. Talcott, "Electrolytic Tritium Production," *Fusion Technol.,* 1990, Vol. 17, p. 680.
117. Chien, C.C., et al., "On an Electrode Producing Massive Quantities of Tritium and Helium," *J. Electroanal. Chem.,* 1992, Vol. 338, p. 189.
118. Sankaranarayanan, M., et al., "Investigation of Low Level Tritium Generation in Ni-H_2O Electrolytic Cells," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
119. Itoh, T., et al., "Observation of Nuclear Products Under Vacuum Conditions from Deuterated Palladium with High Loading Ratio," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
120. Akimoto, T., et al., "Temperature Dependency on Counting Efficiency of NE213 Liquid Scintillator for Low Level Neutron Measurement," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
121. Bruschi, M., U. Marconi, and A. Zoccoli, "The Neutron Spectrometer of the Cold Fusion Experiment under the Gran Sasso Laboratory," in *Hadronic Phys., Winter Course Eighth, 1993* (Singapore: World Sci., 1994).
122. Menlove, H.O. and M.C. Miller, "Neutron-Burst Detectors for Cold-Fusion Experiments," *Nucl. Instrum. Methods Phys. Res. A,* 1990, Vol. 299, p. 10.
123. Aoyama, T., et al., "Highly Reliable Low-Level Neutron Detection Using ^{3}He Proportional Counters," *Radioisot.,* 1991, Vol. 40, p. 188.
124. Cisbani, E., et al., "Neutron Detector for CF Experiments." *Nucl. Instrum. Methods Phys. Res. A,* 2001, Vol. 459, p. 247.
125. Storms, E., "Review of Experimental Observations about the Cold Fusion Effect," *Fusion Technol.,* 1991, Vol. 20, p. 433.
126. Takahashi, A., et al., "Multibody Fusion Model to Explain Experimental Results," *Fusion Technol.,* 1995, Vol. 27, p. 71.
127. Takahashi, A., "Nuclear Products by D_2O/Pd Electrolysis and Multibody Fusion," in *Int. Symp. Nonlinear Phenom. in Electromagnetic Fields, 1992,* ISEM-Nagoya.
128. De Ninno, A., et al., "Evidence of Emission of Neutrons from a Titanium-Deuterium System," *Europhys. Lett.,* 1989, Vol 9, p. 221.
129. Menlove, H.O., et al., "Reproducible Neutron Emission Measurements From Ti Metal in Pressurized D_2 Gas," in *Anomalous Nuclear Effects in Deuterium/Solid Systems, AIP Conference Proceedings 228, 1990* (Brigham Young Univ., Provo, Utah: American Institute of Physics, New York).
130. Kaushik, T.C., et al., "Preliminary Report on Direct Measurement of Tritium in Liquid Nitrogen Treated TiDx Chips," *Indian J. Technol.,* 1990, Vol. 28, p. 667.

131. Jones, S.E., et al., "Observation of Cold Nuclear Fusion in Condensed Matter," *Nature*(London), 1989, Vol. 338, p. 737.

132. Bush, R.T. and R.D. Eagleton, "Experimental Studies Supporting the Transmission Resonance Model for Cold Fusion in Light Water: II. Correlation of X-Ray Emission With Excess Power," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya Japan: Universal Academy Press, Inc., Tokyo, Japan).

133. Cellucci, F., et al., "X-Ray, Heat Excess and ^{4}He in the Electrochemical Confinement of Deuterium in Palladium," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy. 1996* Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).

134. Chen, S., et al., "X-ray Diagnostics in Gas Discharge," *Trends Nucl. Phys.,* 1995, Vol. 12(3), p. 58 (in Chinese).

135. Isagawa, S., Y. Kanda, and T. Suzuki, "Present Status of Cold Fusion Experiment at KEK," *Int. J. Soc. Mat. Eng. Resources,* 1998, Vol. 65(1), p. 60.

136. Iwamura, Y., et al., "Characteristic X-ray and Neutron Emissions from Electrochemically Deuterated Palladium," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).

137. Iyengar, P.K., et al., "Bhabha Atomic Research Centre Studies on Cold Fusion," *Fusion Technol.,* 1990, Vol. 18, p. 32.

138. McKubre, M.C.H., et al., "Calorimetry and Electrochemistry in the D/Pd System," in *First Annual Conference on Cold Fusion, 1990* (Salt Lake City, Utah: National Cold Fusion Institute, University of Utah Research Park).

139. Szpak, S., P.A. Mosier-Boss, and J.J. Smith, "On the Behavior of the Cathodically Polarized Pd/D System: Search for Emanating Radiation," *Phys. Lett. A,* 1996, Vol. 210, p. 382.

140. Takahashi, A., "Results of Experimental Studies of Excess Heat vs Nuclear Products Correlation and Conceivable Reaction Model," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).

141. Wang, D.L., et al., "Experimental Studies on the Anomalous Phenomenon in Pd Metal Loaded with Deuterium," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya Japan: Universal Academy Press, Inc., Tokyo, Japan).

142. Miles, M. and B.F. Bush, "Radiation Measurements at China Lake: Real or Artifacts?" in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).

143. Rout, R.K., et al., "Copious Low Energy Emissions from Palladium Loaded with Hydrogen or Deuterium," *Indian J. Technol.,* 1991, Vol. 29, p. 571.

144. Savvatimova, I. and A.B. Karabut, "Radioactivity of the Cathode Samples after Glow Discharge," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).

145. Dong, S.Y., et al., "Precursors to 'Cold Fusion' Phenomenon and the Detection of Energetic Charged Particles in Deuterium/Solid Systems," *Fusion Technol.,* 1991, Vol. 20, p. 330.

146. Jin, S., et al., "Anomalous Nuclear Events in Deuterium Palladium Systems," in *Second Annual Conference on Cold Fusion, The Science of Cold Fusion, 1991* (Como, Italy: Societa Italiana di Fisica, Bologna, Italy).

147. Kamada, K., "Electron Impact H-H and D-D Fusions in Molecules Embedded in Al.: 1. Experimental Results," *Jpn. J. Appl. Phys. A,* 1992, Vol. 31(9), p. L1287.

148. Li, X.Z., et al., "Anomalous Nuclear Phenomena and Solid State Nuclear Track Detector," *Nucl. Tracks Radiat. Meas.,* 1993, Vol. 22, p. 599.

149. Lipson, A.G., et al., "In-Situ Charged Particles and X-Ray Detection in Pd Thin Film-Cathodes during Electrolysis in Li_2SO_4/H_2O," in *Ninth International Conference on Cold Fusion, 2002* (Beijing, China: Tsinghua University, unpublished).

150. Oriani, R.A. and J.C. Fisher, "Generation of Nuclear Tracks during Electrolysis," *Jpn. J. Appl. Phys. A,* 2002, Vol. 41, pp. 6180-6183.

151. Qiao, G.S., et al., "Nuclear Products in a Gas-Loading D/Pd and H/Pd System," in *Seventh International Conference on Cold Fusion," 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).

152. Roussetski, A.S., "Investigation of Nuclear Emissions in the Process of D(H) Escaping from Deuterized (Hydrogenized) PdO-Pd-PdO and PdO-Ag Samples," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).

153. Rout, R.K., et al., "Update on Observation of Low-Energy Emissions from Deuterated and Hydrated Palladium," *Indian J. Technol.,* 1993, Vol. 31, p. 551.

154. Wang, K.L., et al., "Search for Better Material for Cold Fusion Experiment Using CR-39 Detector," in *Second Annual Conference on Cold Fusion, The Science of Cold Fusion, 1991* (Como, Italy: Societa Italiana di Fisica, Bologna, Italy).

155. Wu, B., et al., "The SEM Observation of Palladium-Deuterium System after the Gas Discharge Process," *Gaojishu Tongxun,* 1991, Vol. 1(9), p. 1 (in Chinese).

156. Miley, G.H., et al., "Quantitative Observations of Transmutation Products Occuring in Thin-Film Coated Microspheres during Electrolysis," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).

157. Miley, G.H., "Possible Evidence of Anomalous Energy Effects in H/D-Loaded Solids-Low Energy Nuclear Reactions (LENRS)," *J. New Energy,* 1997, Vol.2(3/4), p. 6.

158. Mizuno, T., "Experimental Confirmation of the Nuclear Reaction at Low Energy Caused by Electrolysis in the Electrolyte," in *Proceedings for the Symposium on Advanced Research in Energy Technology, 2000* (Hokkaido University).

159. Mizuno, T., et al., "Formation of ^{197}Pt Radioisotopes in Solid State Electrolyte Treated by High Temperature Electrolysis in D_2 Gas," *Infinite Energy,* 1995, Vol. 1(4), p. 9.

160. Bush, R.T., "A Light Water Excess Heat Reaction Suggests That 'Cold Fusion' May Be 'Alkali-Hydrogen Fusion,' " *Fusion Technol.,* 1992, Vol. 22, p. 301.

161. Notoya, R. and M. Enyo, "Excess Heat Production in Electrolysis of Potassium Carbonate Solution with Nickel Electrodes," in *Third International Conference on Cold Fusion, Frontiers of Cold Fusion, 1992* (Nagoya Japan: Universal Academy Press, Inc., Tokyo, Japan).

162. Bush, R.T., "Evidence for an Electrolytically Induced Shift in the Abundance Ratio of Sr-88 and Sr-86," in *International Symposium on Cold Fusion and Advanced Energy Sources, 1994* (Belarusian State University, Minsk, Belarus: Fusion Information Center, Salt Lake City, Utah).

163. Notoya, R., "Cold Fusion Arising from Hydrogen Evolution Reaction on Active Metals in Alkali Metallic Ions Solutions," *Environ. Res. Forum,* 1996, Vol. 1-2, p. 127.

164. Ohmori, T., T. Mizuno, and M. Enyo, "Isotopic Distributions of Heavy Metal Elements Produced during the Light Water Electrolysis on Gold Electrodes," *J. New Energy,* 1996, Vol. 1(3), p. 90.

165. Singh, M., et al., "Verification of the George Oshawa Experiment for Anomalous Production of Iron from Carbon Arc in Water," *Fusion Technol.,* 1994, Vol. 26, p. 266.

166. Jiang, X.L., L.J. Han, and W. Kang, "Anomalous Element Production Induced by Carbon Arcing Under Water," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).

167. Ransford, H.E., "Non-Stellar Nucleosynthesis: Transition Metal Production by DC Plasma-Discharge Electrolysis Using Carbon Electrodes in a Non-Metallic Cell," *Infinite Energy,* 1999, Vol. 4(23), p. 16.

168. Ohmori, T. and M. Enyo, "Iron Formation in Gold and Palladium Cathodes," *J. New Energy,* 1996, Vol. 1(1), p. 15.

169. Ohmori, T., et al., "Transmutation in the Electrolysis of Light Water—Excess energy and Iron Production in a Gold Electrode," *Fusion Technol.,* 1997, Vol. 31, p. 210.

170. Bush, R.T. and R.D. Eagleton, "Evidence for Electrolytically Induced Transmutation and Radioactivity Correlated with Excess Heat in Electrolytic Cells With Light Water Rubidium Salt Electrolytes," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).

171. Savvatimova, I. and A. Karabut, "Nuclear Reaction Products Registration on the Cathode after Glow Discharge," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).

172. Passell, T.O., "Charting the Way Forward in the EPRI Research Program on Deuterated Metals," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).

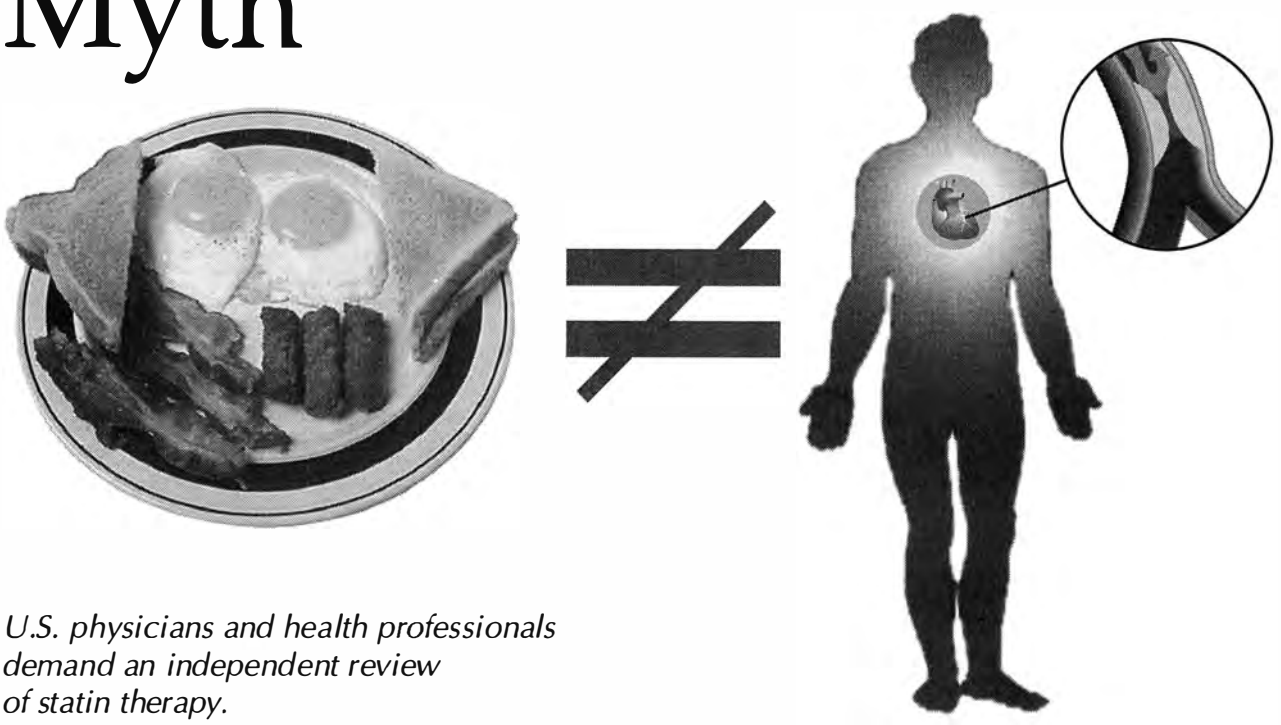
173. Kervran, C.L., *Biological Transmutations,* (Swan House Publishing Co., 1972).

174. Vysotskii, V.I., A.A. Kornilova, and I.I. Samoylovlenko, "Experimental Discovery of Phenomenon of Low-Energy Nuclear Transformation of Isotopes (Mn55 = Fe57) in Growing Biological Cultures," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
175. Vysotskii, V., et al., "Observation and Mass-Spectrometry. Study of Controlled Transmutation of Intermediate Mass Isotopes in Growing Biological Cultures," *Infinite Energy,* 2001, Vol. 6(36), p. 64.
176. Anufriev, G.S. and B.S. Boltenkov, "Helium Isotopes and Hydrogen in Aluminium and Other Metals," *Vopr. At. Nauki Tekh. Ser.: Fiz. Radiats. Povr. Radiats. Materialoved.,* 1991, Vol. 56(2), p. 73 (in Russian).
177. Wang, T., et al., "Study of the Deuterated Titanium Ti_2Hx Samples by Using Nuclear Reaction Analysis (NRA) and Materials Analysis Methods," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
178. Lynch, J.F., J.D. Clewley, and T.B. Flanagan, "The Formation of Voids in Palladium Metal by the Introduction and Removal of Interstitial Hydrogen," *Philos. Mag. A,* 1973, Vol. 28, p. 1415.
179. Jiang, X.L., et al., "Tip Effect and Nuclear-Active Sites," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
180. Huggins, R.A., "Fundamental Considerations Relating to the Electrochemical Insertion of Hydrogen and Palladium into Mixed Conductors," in *Eighth World Hydrogen Energy Conference, 1990* (Honolulu: Hawaii Natural Energy Insitute, 2540 Dole St., Holmes Hall 246, Honolulu, Hawaii 96822).
181. Jamieson, H.C., G.C. Weathrely, and F.D. Manchester, "The b-a Phase Transformation in Palladium-Hydrogen Alloys," *J. Less-Common Met.,* 1976, Vol. 56, p. 85.
182. Bockris, J., D. Hodko, and Z. Minevski, "Fugacity of Hydrogen Isotopes in Metals: Degradation, Cracking and Cold Fusion," in *Symp. Hydrogen Storage Materials, Batteries, Electrochemistry, 1991*, 1991.
183. De Ninno, A., A. La Barbera, and V. Violante, "Deformations Induced by High Loading Ratios in Palladium-Deuterium Compounds," *J. Alloys and Compounds,* 1997, Vol. 253-254, p. 181.
184. Storms, E., "A Study of Those Properties of Palladium That Influence Excess Energy Production by the Pons-Fleischmann Effect," *Infinite Energy,* 1996, Vol. 2(8), p. 50.
185. Lewis, F.A., "The Palladium-Hydrogen System," *Platinum Met. Rev.,* 1982, Vol. 26, p. 121.
186. Flanagan, T.B. and W.A. Oates, "The Palladium-Hydrogen System," *Annu. Rev. Mater. Sci.,* 1991, Vol. 21, p. 269.
187. Oriani, R.A., "The Physical and Metallurgical Aspects of Hydrogen in Metals," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
188. Huggins, R.A., "Materials Aspects of the Electrochemical Insertion of Hydrogen and Deuterium into Mixed Conductors," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
189. Santandrea, R.P. and R.G. Behrens, "A Review of the Thermodynamics and Phase Relationships in the Palladium-Hydrogen, Palladium-Deuterium and Palladium-Tritium Systems," *High Temperature Materials and Processes,* 1986, Vol. 7, p. 149.
190. Gillespie, L.J. and W.R. Downs, "The Palladium-Deuterium Equilibrium," *J. Am. Chem. Soc.,* 1937, Vol. 61, p. 2494.
191. Anderson, I.S., D.K. Ross, and C.J. Carlile, "The Structure of the g Phase of Palladium Deuteride," *Phys. Lett. A,* 1978, Vol. 68, p. 249.
192. Herrero, C. and F.D. Manchester, "Location of the Low Temperature Resistivity Anomaly in Pd-D," *Phys. Lett. A,* 1981, Vol. 86, p. 29.
193. Nishimiya, N., et al., "Hyperstoichiometric Hydrogen Occlusion by Palladium Nanoparticles Included in NaY Zeolite," *J. Alloys and Compounds,* 2001, Vol. 319, p. 312.
194. Arata, Y. and Y.C. Zhang, "Formation of Condensed Metallic Deuterium Lattice and Nuclear Fusion," *Proc. Japan. Acad.,* 2002, Vol. 78(B), p. 57.
195. Wei, S.H. and A. Zunger, "Instability of Diatomic Deuterium in fcc Palladium," *J. Fusion Energy,* 1990, Vol. 9(4), p. 367.
196. Celani, F., et al., "The Effect of g-b Phase on H(D)/Pd Overloading," in *Seventh International Conference on Cold Fusion, 1998* (Vancouver, Canada: ENECO, Inc., Salt Lake City, Utah).
197. Bennington, S.M., et al., "In-Situ Measurements of Deuterium Uptake into a Palladium Electrode Using Time-of-Flight Neutron Diffractometry," *J. Electroanal. Chem.,* 1990, Vol. 281, p. 323.
198. Dillon, C.T., B.J. Kennedy, and M.M. Elcombe, "The Electrochemically Formed Palladium-Deuterium System. II. In Situ Neutron Diffraction Studies," *Aust. J. Chem.,* 1993, Vol. 46, p. 681.
199. Worsham Jr., J.E., M.K. Wilkinson, and C.G. Shull, "Neutron-Diffraction Observations on the Palladium-Hydrogen and Palladium-Deuterium Systems," *J. Phys. Chem. Solids,* 1957, Vol. 3, p. 303.
200. Burger, J.P., et al., "Electrical Resistivity of Pd-Hx: Residual Resistivity," *Solid State Commun.,* 1975, Vol. 17, p. 227.
201. Matsuzaki, A., T. Nishina, and I. Uchida, "In Situ Low Incident Angle XRD Technique with Electrochemical Methods. Application to Deuterium Charging into Palladium Cathode," *Hyomen Gijutsu,* 1994, Vol. 45, p. 106.
202. Asami, N., et al., "Material Behavior of Highly Deuterated Palladium," in *Ninth International Conference on Cold Fusion, 2002*(Beijing, China: Tsinghua University, unpublished).
203. Fukai, Y. and N. Okuma, "Formation of Superabundant Vacancies in Pd Hydride under High Hydrogen Pressures," *Phys. Rev. Lett.,* 1994, Vol. 73, p. 1640.
204. Semiletov, S.A., et al., "Electron-Diffraction Investigation of Tetragonal PdH," *Kristallografiya,* 1980, Vol. 25, p. 665.
205. Baranova, R.V., et al., "Crystal Structure of Pd Hydride with Primitive Cubic Lattice," *Sov. Phys. Crystallogr.,* 1980, Vol. 25, p. 736.
206. Bertalot, L., et al., "Deuterium Charging in Palladium by Electrolysis of Heavy Water: Measurement of Lattice Parameter," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
207. Richards, P.M., "Molecular-Dynamics Investigation of Deuterium Separation in PdD1.1," *Phys. Rev. B: Mater. Phys.,* 1989, Vol. 40(11), p. 7966.
208. Louis, E., et al., "Calculation of Hydrogen-Hydrogen Potential Energies and Fusion Rates in Palladium Hydride ($PdxH_2$) Clusters (x = 2,4)," *Phys. Rev. B: Mater. Phys.,* 1990, Vol. 42, p. 4996.
209. Ludecki, C.M., G. Deublein, and R.A. Huggins, "Thermodynamic Characterization of Metal Hydrogen Systems by Assessment of Phase Diagrams and Electrochemical Measurements," *Int. J. Hydrogen Energy,* 1987, Vol. 12, p. 81.
210. Picard, C., O.J. Kleppa, and G. Boureau, "Thermodynamic Study of the Palladium-Hydrogen System at 245-352°C and at Pressures Up to 34 Atm.," *J. Chem. Phys.,* 1978, Vol. 69, p. 5549.
211. Sakamoto, Y., et al., "Calorimetric Enthalpies for Palladium-Hydrogen (Deuterium) Systems at H(D) Contents up to about [H]([D])/[Pd] = 0.86," *J. Phys.: Condens. Mater.,* 1996, Vol. 8, p. 3229.
212. Flanagan, T.B., W. Luo, and J.D. Clewley, "Calorimetric Enthalpies of Absorption and Desorption of Protium and Deuterium by Palladium," *J. Less-Common Met.,* 1991, Vol. 172-174, p. 42.
213. Godshall, N.A., et al., "Calorimetric and Thermodynamic Analysis of Palladium-Deuterium Electrochemical Cells," *J. Fusion Energy,* 1990, Vol. 9, p. 229.
214. Zhang, W.S., Z.F. Zhang, and Z.L. Zhang, "Some Problems on the Resistance Method in the In Situ Measurement of Hydrogen Content in Palladium Electrode," *J. Electroanal. Chem.,* 2002, Vol. 528, p. 1.
215. Barton, J.C. and F.A. Lewis, "Interface Impedance and the Apparent Electrical Resistance of Palladium Hydrides in Aqueous Solutions," *Trans. Faraday Soc.,* 1962, Vol. 58, p. 103.
216. Baranowski, B., "High Pressure Research on Palladium-Hydrogen Systems," *Pt. Met. Rev.,* 1972, Vol. 16-17, p. 10.
217. Lee, M. and R. Glosser, "Resistivity of Thin Films of the Palladium-Hydrogen System as a Function of Film Thickness," *Zeitschrift fur Physik. Chemie,* 1986, Vol. 147, p. 27.
218. Frazier, G.A. and R. Glosser, "Characterization of Thin Films of the Pd-H System," J. *Less-Common Met.,* 1980, Vol. 74, p. 89.
219. Storms, E., "How to Produce the Pons-Fleischmann Effect," *Fusion Technol.,* 1996, Vol. 29, p. 261.
220. Cravens, D., "Factors Affecting Success Rate of Heat Generation in CF Cells," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
221. Tanzella, F.L., et al., "Parameters Affecting the Loading of Hydrogen Isotopes into Palladium Cathodes," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
222. Szpak, S., P.A. Mosier-Boss, and J.J. Smith, "Reliable Procedure for the Initiation of the Fleischmann-Pons Effect," in *Second Annual Conference on Cold Fusion, The Science of Cold Fusion, 1991* (Como,

Italy: Societa Italiana di Fisica, Bologna, Italy).

223. Celani, F., et al., "High Hydrogen Loading into Thin Palladium Wires through Precipitate of Alkaline-Earth Carbonate on the Surface of Cathode: Evidence of New Phases in the Pd-H System and Unexpected Problems Due to Bacteria Contamination in the Heavy-Water," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
224. McKubre, M.C.H., et al., "Concerning Reproducibility of Excess Power Production," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France).
225. Hasegewa, N., et al., "Observation of Excess Heat During Electrolysis of 1M LiOD in a Fuel Cell Type Closed Cell," in *Fourth International Conference on Cold Fusion, 1993* (Lahaina, Maui: Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, Calif. 94304).
226. Minato, J., et al., "Materials/Surface Aspects of Hydrogen/Deuterium Loading into Pd Cathode," in *Fifth International Conference on Cold Fusion, 1995* (Monte-Carlo, Monac: IMRA Europe, Sophia Antipolis Cedex, France).
227. Kozima, H. and K. Arai, "Local Coherence, Condensation and Nuclear Reaction of Neutrons at Crystal Boundary of Metal Hydrides and Deuterides," *Int. J. Hydrogen Energy,* 2000, Vol. 25(9), p. 845.
228. Fisher, J.C., "Liquid-Drop Model for Extremely Neutron Rich Nuclei," *Fusion Technol.,* 1998, Vol. 34, p. 66.
229. Oriani, R.A., "Anomalous Heavy Atomic Masses Produced by Electrolysis," *Fusion Technol.,* 1998, Vol. 34, p. 76.
230. Mills, R.L. and W.R. Good, "Fractional Quantum Energy Levels of Hydrogen," *Fusion Technol.,* 1995, Vol. 28, p. 1697.
231. Dufour, J.J., J.H. Foos, and X.J.C. Dufour, "Formation and Properties of Hydrex and Deutex," *Infinite Energy,* 1998, Vol. 4(20), p. 53.
232. Liu, F.S., The Phonon Mechanism of the Cold Fusion," *Mod. Phys. Lett. B,* 1996, Vol. 10, p. 1129.
233. Violante, V. and A. De Ninno, "Quantum Mechanical Description of a Lattice Ion Trap," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
234. Kucherov, Y., "Slow Nuclear Excitation Model," in *Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, 1996* (Lake Toya, Hokkaido, Japan: New Energy and Industrial Technology Development Organization, Tokyo Institute of Technology, Tokyo, Japan).
235. Hagelstein, P.L., "A Unified Model for Anomalies in Metal Deuterides," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
236. Chubb, S.R. and T.A. Chubb, "Theoretical Framework for Anomalous Heat and ^{4}He in Transition Metal Systems," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
237. Bazhutov, Y.N., "Erzion Discovery in Cosmic Rays and Its Possible Great Role in Nature in Framework of Erzion Model of Cold Nuclear Transmutation, in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
238. Matsumoto, T., "Mechanisms of Cold Fusion: Comprehensive Explanations by the Nattoh Model," *Mem. Fac. Eng. Hokkaido Univ.,* 1995. Vol. 19(2), p. 201.
239. McKibben, J.L., "The Missed Fractionally-Charged Particles," 1995.
240. Rafelski, J., et al., "Nuclear Reactions Catalyzed by a Massive Negatively Charged Particle. How Cold Fusion Can Be Catalyzed," *Fusion Technol.,* 1990, Vol. 18, p. 136.
241. Fisher, J.C., "Polyneutrons as Agents for Cold Nuclear Reactions," *Fusion Technol.,* 1992, Vol. 22, p. 511.
242. Turner, L., "Thoughts Unbottled by Cold Fusion," *Phys. Today,* 1989, Sept., p. 140.
243. Feng, S., "Enhancement of Cold Fusion Rate by Electron Polarization in Palladium Deuterium Solid," *Solid State Commun.,* 1989, Vol. 72, p. 205.
244. Hora, H., G.H. Miley, and J. Kelly, "Low Energy Nuclear Reactions of Protons in Host Metals," in *Eighth International Conference on Cold Fusion, 2000* (Lerici, La Spezia, Italy: Italian Physical Society, Bologna, Italy).
245. Hora, H., et al., "Proton-Metal Reactions in Thin Films with Boltzmann Distribution Similar to Nuclear Astrophysics," *Fusion Technol.,* 1999, Vol. 36, p. 331.
246. Hora, H., J.C. Kelly, and G.H. Miley, "Energy Gain and Nuclear Transmutation by Low-Energy P- or D-Reaction in Metal Lattices, *Infinite Energy,* 1997, Vol. 2(12), p. 48.
247. Takahashi, A., et al., "Emission of 2.45 MeV and Higher Energy Neutrons from D_2O-Pd Cell under Biased-Pulse Electrolysis," *J. Nucl. Sci. Technol.,* 1990, Vol. 27, p. 663.
248. Isobe, Y., et al., "Search for Multibody Nuclear Reactions in Metal Deuteride Induced with Ion Beam and Electrolysis Methods," *Jpn. J. Appl. Phys. A,* 2002, Vol. 41(1), p. 1546.
249. Takahashi, A., "Tetrahedral And Octahedral Resonance Fusion Under Transient Condensation Of Deuterons At Lattice Focal Points," in *Ninth International Conference on Cold Fusion, 2002* (Beijing, China: Tsinghua University, unpublished).
250. Jones, J.E., et al., "Faradaic Efficiencies Less Than 100% during Electrolysis of Water Can Account for Reports of Excess Heat in 'Cold Fusion' Cells," *J. Phys. Chem.,* 1995, Vol. 99, p. 6973.
251. Miskelly, G.M., et al., "Analysis of the Published Calorimetric Evidence for Electrochemical Fusion of Deuterium in Palladium," *Science,* 1989, Vol. 246, p. 793.
252. Fleischmann, M., et al., "Calorimetry of the Palladium-Deuterium-Heavy Water System," *J. Electroanal. Chem.,* 1990, Vol. 287, p. 293.
253. Shanahan, K., "A Possible Calorimetric Error in Heavy Water Electrolysis on Platinum," *Thermochim. Acta,* 2002, Vol. 387(2), p. 95-101.

Challenging The Cholesterol Myth



U.S. physicians and health professionals demand an independent review of statin therapy.

by Marjorie Mazel Hecht

The latest guidelines of the National Cholesterol Education Program (NCEP) of the National Institutes of Health, issued in July 2004, would have millions more Americans taking statin drugs to reduce their risk of heart disease from cholesterol. But the evidence on which the new guidelines were based has come into question by the medical community—and for good reason: The studies behind the new guidelines don't show what the NCEP says they show, and statin drugs don't lower most people's risk of heart disease.

On Sept. 23, 2004, 35 prominent physicians, epidemiologists, and other scientists wrote to the heads of the National Institutes of Health, the National Heart, Lung, and Blood Institute, and the National Cholesterol Education Program to urge an independent review of the scientific studies on which the new guidelines are based: "There is strong evidence to suggest that an objective, independent re-evaluation of the scientific evidence from the five new studies of statin therapy would lead to different conclusions than those presented by the current National Cholesterol Education Program," the letter states.

Among the signers of the letter are John Abramson, M.D., Clinical Instructor, Primary Care, Harvard Medical School; R. James Barnard, Ph.D., Professor, Department of Physiological Science at UCLA; Christopher Gardner, Ph.D., Assistant Professor of Medicine, Stanford University; Jerome R.

Hoffman, M.D., Professor of Medicine, UCLA School of Medicine; Marion Nestle, Ph.D., Paulette Goddard Professor of Nutrition, Food Studies, and Public Health, New York University; David L. Brown, M.D., Professor of Medicine and Epidemiology, Albert Einstein College of Medicine and Director, Interventional Cardiology, Beth Israel Medical Center; and the Center for Science in the Public Interest.

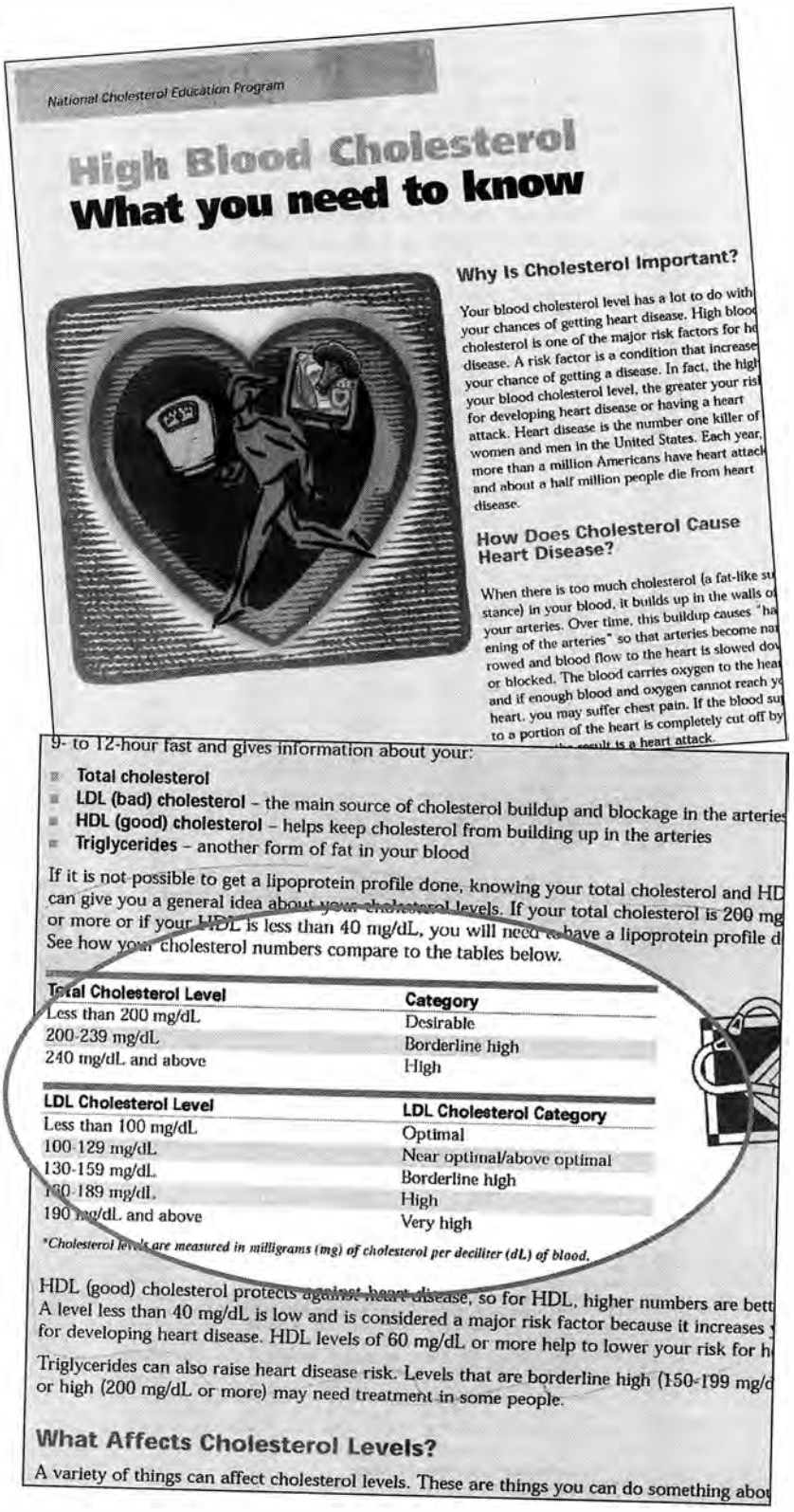
The letter notes that eight of the nine authors of the July recommendations have financial ties to statin manufacturers, including Pfizer, Merck, Bristol-Meyers Squibb, and AstraZeneca, a fact that was not made known when the recommendations were first published in the journal *Circulation*. "Such conflicts," the letter states, "certainly could affect authors' judgment and undermine public confidence in the report. . . . But like surrogate endpoints in clinical studies, the conflicts are a diversion from the most important question: Are these lower LDL [low-density lipoproteins, or "bad" cholesterol] targets justified by the scientific evidence?"

The authors outline four major objections to the NCEP interpretation of the data. First, the letter states, "We believe the evidence does not support extending these guidelines to women who are at moderately high risk of CVD [cardio-vascular disease] (so-called 'primary prevention')." Not one of the six studies used "provides significant evidence to support" the claim that "statins reduce the risk of heart disease in moderately high risk women under the age of 65."

Second, the letter states, "We believe the evidence does not support extending these guidelines to older persons who are at risk of CVD (primary prevention)." There were nine studies involved, and not one of them "provided signficant evidence that statins protect senior citizens without heart disease." The authors of the letter note that those above 65 and treated with a statin "did not experience signficantly fewer heart attacks and strokes. But they did develop 25 percent more new cancers than the people in the control group (statistically significant)."

Third, the authors state: "We believe the evidence in the five latest clinical trials for extending these guidelines to primary prevention of coronary heart disease in patients with diabetes is mixed." They note that for 250 diabetic patients treated with a statin, in one study, "one death was prevented each year"—but four times as many lives would be saved if those sedentary diabetic patients would become physically active. "The relative importance of statin therapy and routine exercise was not mentioned in the NCEP recommendations," the authors note.

Fourth, the authors state that one study, designated as ALLHAT, "did not show a benefit from more than tripling the number of people taking statins (as rec-



National Cholesterol Education Program

High Blood Cholesterol
What you need to know

Why Is Cholesterol Important?

Your blood cholesterol level has a lot to do with your chances of getting heart disease. High blood cholesterol is one of the major risk factors for heart disease. A risk factor is a condition that increases your chance of getting a disease. In fact, the higher your blood cholesterol level, the greater your risk for developing heart disease or having a heart attack. Heart disease is the number one killer of women and men in the United States. Each year, more than a million Americans have heart attacks and about a half million people die from heart disease.

How Does Cholesterol Cause Heart Disease?

When there is too much cholesterol (a fat-like substance) in your blood, it builds up in the walls of your arteries. Over time, this buildup causes "hardening of the arteries" so that arteries become narrowed and blood flow to the heart is slowed down or blocked. The blood carries oxygen to the heart and if enough blood and oxygen cannot reach your heart, you may suffer chest pain. If the blood supply to a portion of the heart is completely cut off by a blood clot, the result is a heart attack.

9- to 12-hour fast and gives information about your:

- **Total cholesterol**
- **LDL (bad) cholesterol** – the main source of cholesterol buildup and blockage in the arteries
- **HDL (good) cholesterol** – helps keep cholesterol from building up in the arteries
- **Triglycerides** – another form of fat in your blood

If it is not possible to get a lipoprotein profile done, knowing your total cholesterol and HDL can give you a general idea about your cholesterol levels. If your total cholesterol is 200 mg/dL or more or if your HDL is less than 40 mg/dL, you will need to have a lipoprotein profile done. See how your cholesterol numbers compare to the tables below.

Total Cholesterol Level	Category
Less than 200 mg/dL	Desirable
200-239 mg/dL	Borderline high
240 mg/dL and above	High

LDL Cholesterol Level	LDL Cholesterol Category
Less than 100 mg/dL	Optimal
100-129 mg/dL	Near optimal/above optimal
130-159 mg/dL	Borderline high
160-189 mg/dL	High
190 mg/dL and above	Very high

**Cholesterol levels are measured in milligrams (mg) of cholesterol per deciliter (dL) of blood.*

HDL (good) cholesterol protects against heart disease, so for HDL, higher numbers are better. A level less than 40 mg/dL is low and is considered a major risk factor because it increases your risk for developing heart disease. HDL levels of 60 mg/dL or more help to lower your risk for heart disease.

Triglycerides can also raise heart disease risk. Levels that are borderline high (150-199 mg/dL) or high (200 mg/dL or more) may need treatment in some people.

What Affects Cholesterol Levels?

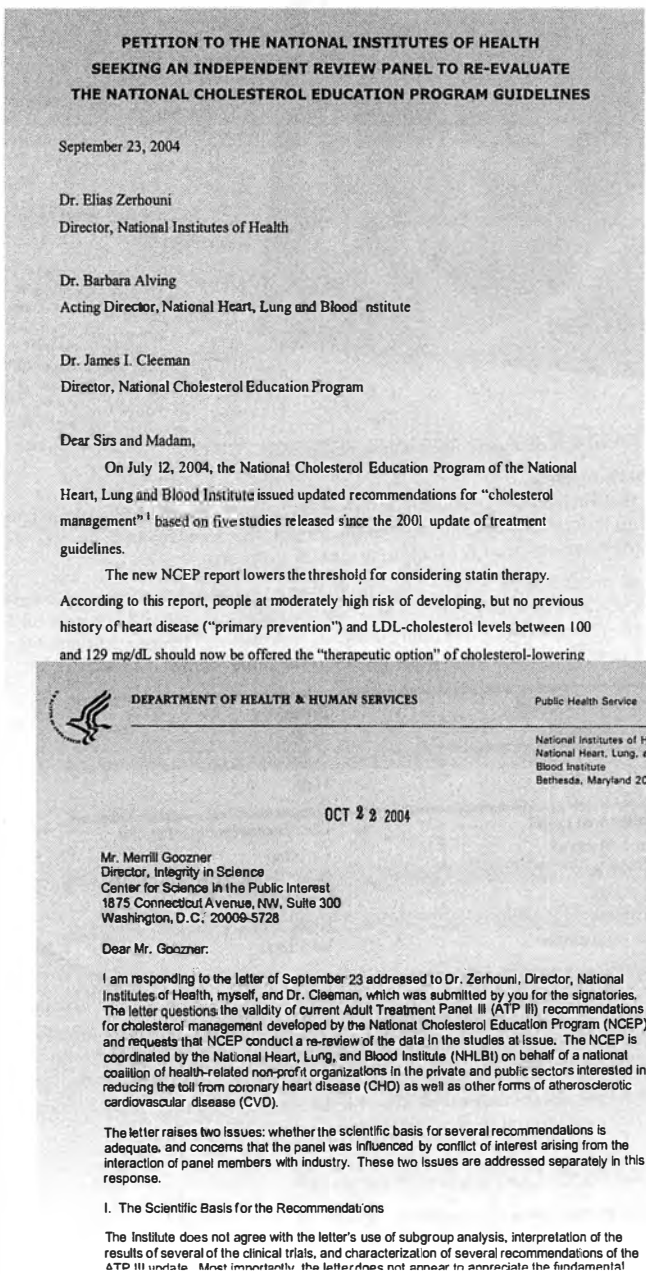
A variety of things can affect cholesterol levels. These are things you can do something about.

The July 2004 guidelines of the National Cholesterol Education Program have lowered the threshold for recommending statin drugs, making millions more Americans candidates for these expensive and questionable drugs.

ommended by the 2001 and 2004 NCEP updates). . . . The results show that tripling the number of people taking statins . . . provides no additional benefit—not to those older or younger, male or female, with or without diabetes, with or without heart disease, and among those without heart disease, not to those with LDL-cholesterol higher or lower than 130 mg/dL. The only group that derived any significant benefit from more statins was African-Americans, who had fewer episodes of heart disease, but not fewer deaths. . . ."

In conclusion, the authors state: "The American people are poorly served when government-sanctioned clinical recommendations, uncritically amplified by the media, misdirect attention and resources to expensive medical therapies that may not be scientifically justified. Only an independent review, totally free from conflicts of interest, can restore public confidence by determining if that has happened in this case. We therefore request that you move expeditiously to appoint such a panel and provide it with the resources needed to conduct the review."

Thirty-five physicians and health professionals, and the Center for Science in the Public Interest, sent a petition Sept. 23, 2004, to the National Institutes of Health calling for an independent review panel to re-evaluate the cholesterol guidelines. ▼



PETITION TO THE NATIONAL INSTITUTES OF HEALTH SEEKING AN INDEPENDENT REVIEW PANEL TO RE-EVALUATE THE NATIONAL CHOLESTEROL EDUCATION PROGRAM GUIDELINES

September 23, 2004

Dr. Elias Zerhouni
Director, National Institutes of Health

Dr. Barbara Alving
Acting Director, National Heart, Lung and Blood nstitute

Dr. James I. Cleeman
Director, National Cholesterol Education Program

Dear Sirs and Madam,

On July 12, 2004, the National Cholesterol Education Program of the National Heart, Lung and Blood Institute issued updated recommendations for "cholesterol management"[1] based on five studies released since the 2001 update of treatment guidelines.

The new NCEP report lowers the threshold for considering statin therapy. According to this report, people at moderately high risk of developing, but no previous history of heart disease ("primary prevention") and LDL-cholesterol levels between 100 and 129 mg/dL should now be offered the "therapeutic option" of cholesterol-lowering

DEPARTMENT OF HEALTH & HUMAN SERVICES — Public Health Service

National Institutes of Health
National Heart, Lung, and Blood Institute
Bethesda, Maryland 20892

OCT 22 2004

Mr. Merrill Goozner
Director, Integrity in Science
Center for Science in the Public Interest
1875 Connecticut Avenue, NW, Suite 300
Washington, D.C. 20009-5728

Dear Mr. Goozner:

I am responding to the letter of September 23 addressed to Dr. Zerhouni, Director, National Institutes of Health, myself, and Dr. Cleeman, which was submitted by you for the signatories. The letter questions the validity of current Adult Treatment Panel III (ATP III) recommendations for cholesterol management developed by the National Cholesterol Education Program (NCEP) and requests that NCEP conduct a re-review of the data in the studies at issue. The NCEP is coordinated by the National Heart, Lung, and Blood Institute (NHLBI) on behalf of a national coalition of health-related non-profit organizations in the private and public sectors interested in reducing the toll from coronary heart disease (CHD) as well as other forms of atherosclerotic cardiovascular disease (CVD).

The letter raises two issues: whether the scientific basis for several recommendations is adequate, and concerns that the panel was influenced by conflict of interest arising from the interaction of panel members with industry. These two issues are addressed separately in this response.

I. The Scientific Basis for the Recommendations

The Institute does not agree with the letter's use of subgroup analysis, interpretation of the results of several of the clinical trials, and characterization of several recommendations of the ATP III update. Most importantly, the letter does not appear to appreciate the fundamental

▲ *Dr. Barbara Alving, acting director of the National Heart, Blood, and Lung Institute, answered the Sept. 23 letter on Oct. 22, saying that "the Institute does not believe a re-review of the data is warranted at this time," and defending the integrity of the guidelines.*

The Fat Wars

This latest battle over cholesterol takes place after more than 40 years of propaganda—unsubstantiated by scientific evidence—that a low-fat, low-cholesterol diet will lower your risk of heart disease. One of the principal investigators in the famous Framingham Study of heart disease, George V. Mann, M.D., called this "the great diet-heart scam," and "the greatest scientific deception of our times." Mann devoted much of his career to promoting the truth—as opposed to the officially sponsored fiction, and he named the names of those in the medical profession who preferred their funding from the corn oil companies to telling the truth. These doctors, including Harvard's famed Frederick Stare, shamelessly spread the line that polyunsaturated vegetable fats were good for your heart, while animal fats, like butter and lard, were bad. As Mann characterized those scientists who accepted the diet-heart idea: "Fearing to lose their soft money funding, the academicians who should speak up and stop this wasteful anti-science are strangely quiet. Their silence has delayed a solution for coronary heart disease by a generation."

Mann organized a conference on the issue in November 1991 in Washington, D.C. In the invitation to the conference he wrote: "Hundreds of millions of tax dollars are wasted by the bureaucracy and the self-interested Heart Association. Segments of the food industry play the game for profits. Research on the true causes and prevention is stifled by denying funding to the 'unbelievers.' This meeting will review the data and expose the rascals."[1]

In an article in *Nutrition Today* magazine, Mann wrote: "Those who manipulate data do not appreciate that understanding the nature of things cannot be permanently distorted—the true explanations cannot be permanently ignored. Inexorably, truth is revealed and deception is exposed. . . . In due time, truth will come out. This is the relieving grace in this sorry sequence."

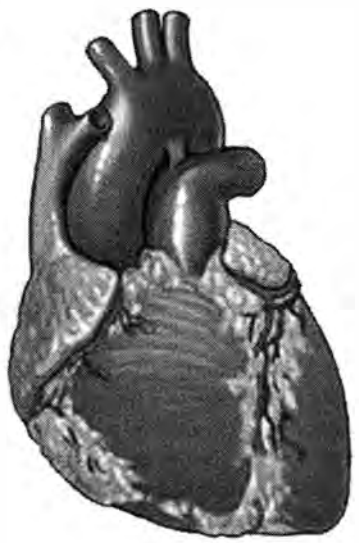
Although more than a decade has passed since Mann made these statements, the truth is still waiting to "come out."

Notes

1. An article by George Mann, "The Great Diet-Heart Scam," appeared in the May-June 1989 issue of *21st Century Science & Technology* magazine.

Agricultural Research Service/USDA

High blood cholesterol and heart attacks are co-symptoms of an unhealthful dietary regime—one with too much sugar and carbohydrates, the authors argue.



Two public health scientists dissect the myth that high cholesterol causes heart disease. But, take heart: they also propose a reasonable course of action for the health-conscious.

The Role of Cholesterol and Diet In Heart Disease

by Alice Ottoboni, Ph.D. and Fred Ottoboni, M.P.H., Ph.D.

Shortly after World War II, the increasing incidence of coronary heart disease[1] prompted the medical community, with government support, to initiate a massive and long-term study of what might possibly be the cause. The study, known as the Framingham Study, enrolled a large number of families whose diets, lifestyles, and environments were surveyed and their medical and laboratory findings routinely recorded. After several years, it was noted that there was a positive association between blood cholesterol levels and incidence of heart attacks.

During this same period, nutrition pioneer Ancel Keys and his wife, Margaret, discovered a regional culinary tradition they named the Mediterranean diet. Convinced that this diet, which was considered low in animal fats, protected against

The authors are long-time public health scientists, now retired. This article is adapted from their book, The Modern Nutritional Diseases: Heart Disease, Stroke, Type-2 Diabetes, Obesity, Cancer and How to Prevent Them, *published in 2002 by Vincente Books, Sparks, Nev., P.O. Box 50704, Sparks, NV 89435. The cover price of the book is $29.95. The publisher sells the book directly by mail order for $19.95 with free shipping in the USA, with payment by check (made out to Vincente Books, Inc.).*

1. Heart disease is a catch-all for a wide and varied group of afflictions of the heart that compromise its ability to perform adequately its job of pumping blood to all parts of the body to deliver nutrients and remove waste products. The heart disease that is the most common cause of cardiovascular disability and death, better known as a heart attack, is referred to as coronary heart disease (CHD), and is the subject of this discussion.

coronary heart disease, they set out to obtain statistics on deaths from coronary heart disease and fat consumption from countries that had such statistics. They found strong associations between the two in six countries. These associations were taken as proof of cause and effect and, with support of the cholesterol-heart disease suggestion from the Framingham Study, gave rise to the *lipid hypothesis,* also referred to as the *cholesterol hypothesis,* for coronary heart disease.

The research of Ancel Keys and his colleagues became widely publicized and popular. The nutrition community enthusiastically adopted the lipid hypothesis, and clinical and epidemiological research in the field proliferated. The lipid hypothesis was accepted as fact by the medical community, and, in 1956, representatives of the American Heart Association presented the hypothesis on national television. The public was informed that the cause of coronary heart disease was butter, lard, beef, and eggs. The diet recommended by the American Heart Association replaced these traditional foods with vegetable seed oils, margarine, chicken, bread, and cereals. This was the birth of the heart-healthy diet that soon became formalized in the government-sponsored low-fat, high-carbohydrate dietary policy that was adopted and followed by millions of Americans for over fifty years.

An in-depth examination of the body of literature on which the government-sponsored dietary policy was founded reveals serious flaws in experimental design and data evaluation. The most flawed of the studies that introduced the lipid hypothesis was that of Ancel Keys. Although Keys presented data from six countries that had statistics on heart attack deaths and fat consumption, there were actually over twenty that had such sta-

Dietary Changes and Disease

Today, the United States is experiencing epidemics of cardiovascular diseases, obesity, type-2 diabetes, and cognitive disturbances, such as senile dementias and Alzheimer's disease. These chronic debilitating diseases are not new diseases, but old diseases that were uncommon prior to 1900, but have now become sources of great societal and economic concern for the health care community and the government. For example, heart disease was rare before 1892. Twenty years later, heart disease was responsible for slightly more than 10 percent of all deaths in advanced nations. By 2001, it was responsible for 31 percent of all deaths in the United States. With the exception of the age group 45-64 years, in which surgical intervention is most common, deaths from heart disease in the United States have continued to rise.

Since the late 19th Century, a gradual but dramatic change in the American diet also has taken place. The family farm has largely disappeared, and an agricultural industry based on mechanization has emerged. Better transportation and new methods of food storage, preparation, and preservation have reduced costs and brought a wider array of fresh and processed foods to the American table.

There is no argument that the American diet has undergone marked changes over past decades. It is also clear that attack rates of chronic debilitating diseases have increased significantly during the same period. But are dietary changes that have occurred over the past century the cause of these diseases?

The concept that large-scale changes in dietary patterns can result in disease is not novel or unreasonable. Considerable historical precedent for this concept can be found in the classic nutritional deficiency diseases. Pellagra and beriberi are just two of the long-forgotten nutritional diseases that once were scourges of mankind. The cause of pellagra is deficiency of the B-vitamin niacin. Pandemics of pellagra were rampant in poor countries where the traditional diet of meat, eggs, and dairy products had been replaced by corn as the staple food. Corn was inexpensive and abundant but essentially devoid of niacin.

Beriberi occurred not because of food cost but because of food instability. Whole grains have short storage lives because oils in the germ readily become rancid. To solve this problem, machines were developed to remove the germ. Unfortunately, along with the germ, they removed the B vitamins. Substitution of refined grains for the rancid-prone whole grains caused mass epidemics of beriberi, a deficiency primarily of the B-vitamin thiamin.

Dietary Changes in Last 100 Years

What are the large-scale dietary changes that have accompanied the current epidemics of chronic debilitating diseases? Before 1900, sugar was a luxury item obtained from sugar cane. Development of the sugar beet industry reduced the cost of sugar, and the sugar bowl became a fixture on the dining table. In addition, new processes to obtain sugar from corn made sweet commercial products, particularly soft drinks, widely available and affordable. The use of sugars has doubled in the last century.

After World War II, abundant supplies of grains, combined with advances in commercial production and distribution of bakery products and pastas, made refined wheat products common staples. About this time, prepackaged breads, cookies, and other ready-to-eat food products found growing public acceptance. The result has been a great increase in dietary use of foods high in sugars and starches.

Development of new sources of edible fats and oils, primarily from vegetable seeds, began in the early 1900s. Prior to that time, the major sources of dietary fat were butter, lard, coconut oil, and olive oil. The new oils required a process called hydrogenation to keep them from smoking during cooking and becoming rancid in storage.

tistics available at the time. Why did Keys exclude the latter data? The fact is that the countries excluded did not show the same association between fat consumption and deaths from heart attacks. In a thoughtful analysis in *The Cholesterol Myths,* Swedish physician Uffe Ravnskov clearly explained that if Keys had included data from all 22 countries, support for Keys's hypothesis would have been weak. Ravnskov went on to conclude that, based on a thorough review of all relevant scientific literature, the lipid-cholesterol hypothesis is a fallacy.

During the next two decades, many nutrition studies investigated the diet/heart connection. Unfortunately, the epidemiological competence of many investigators left much to be desired. In numerous studies, only fat consumption of participants was recorded, to the exclusion of all other diet components. To their credit, a few scientists reported that people who consumed high levels of saturated fat also consumed high levels of sugar. They implicated sugar as the major dietary cause of coronary heart disease with convincing data correlating coronary heart disease to sugar consumption, but their data were ignored. By this time, the direction of research was firmly controlled by proponents of the lipid hypothesis, which already had been expanded to include dietary cholesterol as a culprit.

Even in face of the general acceptance of the lipid hypothesis, a number of scientists were skeptical, claiming that, despite the numerous studies of population groups in many countries, epidemiological methods had not identified the causes of cardiovascular diseases. An extensive review of the literature prior to 1977, including data from the massive Framingham Study, confirmed that the information available concerning the impact of diet on cardiovascular disease did not produce a clear picture of cause and effect. Thus, long after the public was urged to change its dietary habits, the true causes of cardiovascular diseases were still obscure.

Despite this confusing situation, it is apparent that sometime before 1970, those responsible for food policy in the United States had decided that dietary fat, particularly saturated fat and cholesterol, was the cause of high cholesterol, high blood pressure, and coronary heart disease. As a result, the low-fat, high-carbohydrate, "heart-healthy" diet sponsored by the government was adopted by millions of Americans. Thus, those who governed national dietary policy more than 30 years ago directed a whole nation, using a flawed road map, down a dietary path they promised would lead to a healthier life. The map seems to have been drawn using the simplistic but faulty logic that the fat and cholesterol that clogs arteries must have come from the fat and cholesterol in the diet. That this logic is not founded on scientific fact is easily demonstrated by the biochemistry of fat and cholesterol synthesis found even in college textbooks.

Proponents of the lipid hypothesis argue that some patients have success in lowering blood cholesterol on a very low-fat Pritikin-like diet that eliminates animal fats. This is true, but not because the diet is very low in fat, but because it is very low in calories. If a body has no calories in excess of its daily energy requirements, it cannot have calories to divert to cholesterol synthesis. Further, Pritikin-like diets are not useful as a long-term strategy because, being very low in fat, they tend to be deficient in protein and essential fatty acids and because lowering blood cholesterol, per se, does not prevent coronary heart disease.

What Is Cholesterol?

Cholesterol is the principal sterol (steroid alcohol) in higher animals, and is an indispensable constituent of all cells and fluids of the body. It is a large, complex chemical present in the lipid fraction of the diet in combination with the true fats—the fatty acids and their triglycerides. Because the true fats are the most prevalent and familiar lipids in the diet, the term *fat* has become synonymous with *lipid* in nutrition vocabulary, with the result that cholesterol is often erroneously classed as a fat.

Cholesterol comprises up to 50 percent of cell membrane

Hydrogenation not only produces trans fats but also virtually destroys one of two essential fatty acids required for life and health. As a result, Americans are now consuming an average of 40 pounds a year of fats that never before in history were part of the human diet. These new fats have largely replaced animal fats that, unlike vegetable seed oils, contain a healthful balance of the essential fatty acids.

As radical as these dietary modifications were, even more profound changes resulted from acceptance in the late 1940s, by the nutrition and medical communities, of the lipid hypothesis originally proposed by Ancel Keys. Saturated fats and cholesterol were identified as the cause of cardiovascular diseases, with the result that red meat, eggs, and animal fats were demonized. The consumption of these foods declined markedly, and the void was filled with starches, sugars, and vegetable fats.

The dietary changes that have occurred over the past century have had a marked effect on the nutrition of the American public. What is the relationship between diet and nutrition, and why does a change in one influence the other? Diet refers to the foods that comprise the daily fare, and nutrition refers to the substances (nutrients) that the body requires for growth, maintenance, and repair, which are provided by foods.

Because all foods are composed of the same few basic nutrients (proteins, carbohydrates, fats and other lipids, vitamins, and minerals), except in different proportions, the nutritional quality of a diet is completely dependent on what foods are selected to be in it. Thus, if diet contributes to or causes a chronic debilitating disease, the fault must lie in the kinds and quantities of the foods that are selected for the diet. Heart disease, probably the best known and most feared of the modern nutritional diseases, can serve as an example for all such diseases of how diet can cause illness.

lipids, where its function is to regulate membrane flexibility. In addition to other vital biochemical and physiological functions, cholesterol is the starting point for the synthesis of several groups of very important biochemicals, including the male and female sex hormones, vitamin D, and the bile acids.

Cholesterol is transported in the blood in combination with specialized proteins. These combinations form lipid-protein molecules of varying density, hence the familiar LDLs and HDLs (low-density and high-density lipoproteins) that are routinely measured in medical examinations. In general, LDL transports cholesterol to all parts of the body where it is needed. Because one of these needs is to deposit cholesterol over inflamed arterial lesions, LDL has been labeled as "bad." This designation is unfortunate because the deposition is a mechanism to protect against further damage, rather than a cause of damage. Conversely, HDL is labeled "good" because it carries cholesterol away from the body for eventual disposal.

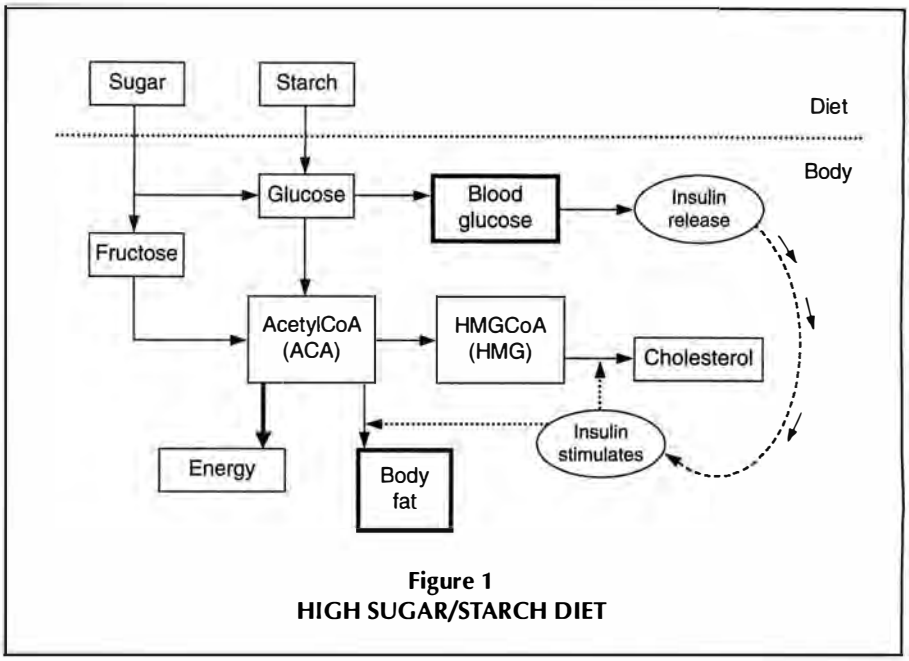


Figure 1
HIGH SUGAR/STARCH DIET

Synthesis of cholesterol occurs in virtually all cells of the body, including the walls of arteries, but the major portion is synthesized by liver cells. Synthesis is controlled by mechanisms that turn the process on and off, depending on the body's needs. Under normal circumstances, the body produces no more cholesterol than its life processes require. Excess cholesterol is excreted from the body by the liver, via the gallbladder, into the small intestine, and eliminated with the feces.

Despite considerable scientific data showing that high blood cholesterol and heart attacks do not have a causal relationship, but rather are co-symptoms of an unhealthful dietary regime, the nutritional and medical communities continue to insist that high blood cholesterol is dangerous and must be reduced. This fixation on cholesterol as a marker for coronary heart disease makes it essential that patients, and potential patients who are concerned for their long-term health, not only understand the significance of blood cholesterol, but also know how diet is responsible for high blood cholesterol levels.

Diet and Cholesterol

Dietary cholesterol, which is present only in foods from animal sources, is poorly absorbed from the intestines. Cholesterol in foods does not cause a significant increase in a person's normal level of blood cholesterol, despite misinformation to the contrary. Very high intakes of dietary cholesterol may increase blood cholesterol levels a few percent, but intakes below 800 milligrams a day have little impact. This is because healthy individuals maintain relatively constant levels of blood cholesterol regardless of the quantity of cholesterol in the diet. The amount of cholesterol the body synthesizes is reduced by whatever quantity of cholesterol is absorbed from the intestinal tract. The more cholesterol in the diet, the less cholesterol the body makes. The human body is a very energy-saving machine in all aspects of its biochemistry, not just in cholesterol synthesis. It does not waste energy in making what is provided by an outside source.

The biosynthesis of cholesterol is governed primarily by the hormone insulin, the secretion of which depends on blood glucose level. Figure 1 is a simplified diagram showing the pathways that dietary carbohydrates, which are largely sugar and starch, follow on their way to cholesterol. Starch is broken down to glucose, which is absorbed into the body where it causes release of insulin from the pancreas. Then, in a series of about 10 biochemical reactions called glycolysis, glucose yields acetyl CoA (ACA). Sugar is absorbed into the body where it splits in two, to yield glucose and fructose. The glucose half goes to ACA via glycolysis, but fructose bypasses glycolysis and goes directly to ACA.

A major function of ACA is to provide energy for life processes, but it is also a precursor of other important biochemicals, including cholesterol and fats. Figure 1 shows two multi-step pathways for ACA. One goes through HMG CoA (HMG) to cholesterol, and the other goes to body fat. Both of these pathways require insulin to proceed. In brief, the amount of glucose in the blood dictates the amount of insulin produced by the pancreas, and this insulin, in turn, directs ACA to go to cholesterol and body fat.

When the blood glucose level drops, as with low-carbohydrate diets, the insulin level falls and the pancreas secretes its complement hormone glucagon. Figure 2 shows this shift in metabolic pattern to one that spares glucose for its critical homeostatic role in blood. In this glucagon-governed pattern, the glucose required to main-

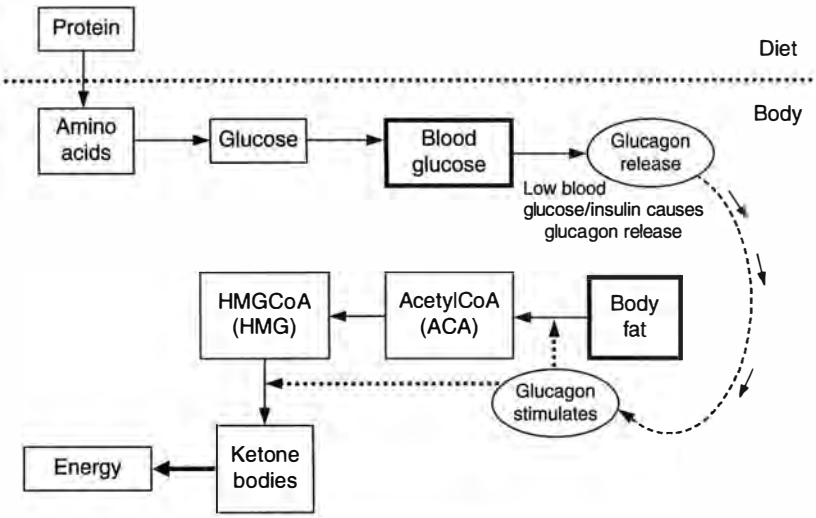


Figure 2
LOW SUGAR/STARCH DIET

tain blood glucose levels is made from amino acids provided by protein. To further spare glucose from being diverted to provide energy, glucagon causes the release of fat from stored body fat, and converts it to HMG through ACA. Then, instead of HMG going to cholesterol, it is converted to ketone bodies, which are used to provide energy.

The metabolic pathway for a diet balanced in nutrients is essentially a composite of Figures 1 and 2. After a full meal, Figure 1 dominates, and several hours later, when dietary nutrients are not available and hunger pangs occur, Figure 2 dominates.

Even though dietary cholesterol does not cause a significant increase in normal cholesterol levels, imbalances of other nutrients in the diet can force the body to synthesize more cholesterol than it requires. Such dietary imbalances override the cholesterol-synthesizing control mechanisms, and cause the body itself to overproduce cholesterol by the pathway shown in Figure 1. This excess production of cholesterol results in an abnormal increase in blood cholesterol.

High levels of blood cholesterol are the result of long-term dietary excesses of sugars and starches. The sugars are provided by soft drinks, candy, and sweet bakery products; and the starches are provided by bread, cereals, potatoes, and pastas. The medical significance of high blood cholesterol for coronary heart disease in the absence of arteriosclerosis can be debated, but there is no doubt that high blood cholesterol is a warning signal that the diet is laying the foundation for coronary heart disease. A diet that causes high blood cholesterol promotes obesity, insulin resistance, and chronic inflammation, all of which are powerful risk factors for coronary heart disease, in addition to other chronic debilitating diseases.

Why is the public so ill-informed on the subject of cholesterol? Many studies published in scientific journals over the past decades have been critical of the lipid hypothesis. These journals, unfortunately, are not usually read by the general public. The mass media, which is the principal source of medical and health information for most people, does not publish information that is counter to the dictates of the establishment. Thus, there has been little recognition by the average citizen that a cholesterol controversy exists in the scientific community.

The public owes a debt of gratitude to Uffe Ravnskov for his role in bringing serious questions about the need for, and dangers of, cholesterol treatment to public attention. Dr. Ravnskov, a Swedish physician and researcher, became concerned about the scientific inaccuracies and misstatements put forth by the anti-cholesterol campaign when it was introduced in Sweden in 1989. As a result, Dr. Ravnskov devoted himself to communicating the scientific facts about cholesterol to patients and potential patients through articles, books, and the Internet. Dr. Ravnskov's writings explain, in lay language, the myths concerning the relationship between cholesterol and coronary heart disease.

The Role of Homocysteine

At this point, *arteriosclerosis* and *atherosclerosis* require definition. Arteriosclerosis refers to hardening of the arteries. It is observed as toughened areas that often contain calcium deposits called plaques. Atherosclerosis refers to an advanced form of arteriosclerosis that is characterized by deposits of cholesterol, fats, and blood clots within the arterial plaques. This distinction is basic to an understanding of the role of nutrients in the development and progression of coronary heart disease.

Arteriosclerosis appears to be a necessary precondition for atherosclerosis. When arteriosclerotic lesions occur, the body deposits cholesterol in the lesion to heal and protect it from further damage. Arteriosclerosis has no relationship to blood cholesterol level. Cholesterol deposition occurs in arteriosclerotic lesions regardless of how low the blood cholesterol level is, and it does not deposit in healthy vessels regardless of how high the cholesterol level is. This explains the seeming paradox of why some people with low cholesterol suffer heart attacks and some people with high cholesterol do not. The explanation can be found in the role of *homocysteine*.

The theory that homocysteine is intimately involved in cardiovascular disease was proposed by Kilmer McCully, a Harvard physician and research scientist, more than 30 years ago. Homocysteine, formed in the body from the amino acid methionine, plays a valuable biochemical role in normal, healthy metabolism; however, like many otherwise valuable biochemicals, homocysteine does damage

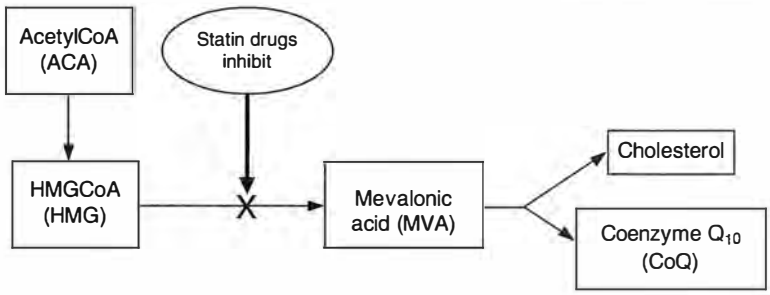
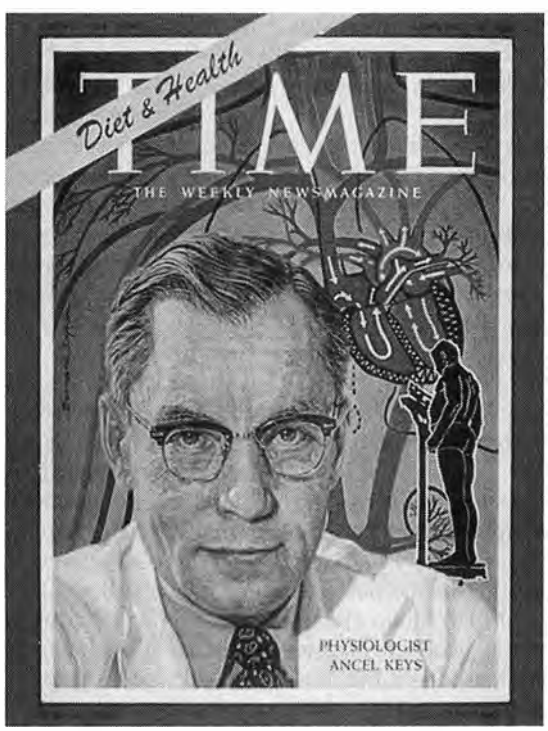


Figure 3
INHIBITION OF CHOLESTEROL BY STATIN DRUGS

when its normal metabolism is disrupted. In the case of homocysteine, the metabolic disruption is caused by deficiencies of three B vitamins, B6, B12, and folic acid, which give rise to excessive levels in the blood. High blood homocysteine damages the walls of arteries and causes them to thicken, lose their elasticity, and form plaques and blood clots. This condition is the arteriosclerosis that predisposes to atherosclerotic diseases, including heart attacks and strokes.

There is ample clinical evidence to support the suggestion that homocysteinemia is a far more accurate predictor of coronary heart disease than is a high cholesterol level. However, because these findings are in conflict with the dogma that cholesterol and fats cause coronary heart disease, they are apparently unacceptable to the medical establishment. Today, clinical laboratories have the ability to measure homocysteine levels as part of routine blood analyses, yet such analyses are rarely requested in medical practice.

Why is it that medical practice essentially ignores the role of homocysteine in coronary heart disease and stresses the importance of cholesterol? Both biochemicals are amenable to being kept within normal values by diet; homocysteine with supplementation of the appropriate B vitamins and cholesterol with a low sugar and starch diet. Further, high blood homocysteine is a valid risk factor for coronary heart disease, whereas high blood cholesterol is no more than a questionable risk factor, except perhaps when accompanied by arteriosclerosis. Thus, the obvious answer to the question is that there are no drugs that can lower blood homocysteine, but there are drugs that can lower blood cholesterol. These are the drugs known as statins.



Manipulating selective data, Ancel Keys popularized the "Mediterranean Diet," which was low in animal fats, as a protection against heart disease. This later evolved into the cholesterol hypothesis. Its general acceptance was noted by Time *magazine in this 1961 cover story.*

Treatment of Heart Disease

The statin drugs are a class of compounds, commonly referred to as cholesterol pills, which include such trade names as Crestor™, Lipitor™, Mevacor™, and Zocor™. Although slightly different in structure, all statins lower blood cholesterol by inhibiting the biochemical conversion of HMG to mevalonic acid (MVA), which, in turn, is converted by a series of biochemical reactions to cholesterol (Figure 3).

As with most drugs, the statins have side effects—unanticipated biochemical reactions incidental to the desired one. Side effects may or may not be harmful. One harmful reaction of the statins is the inhibition of the body's ability to manufacture coenzyme Q10 (CoQ). Figure 3 shows that MVA is not only a precursor of cholesterol but also a precursor of CoQ. Thus, by inhibiting biosynthesis of cholesterol, statins also inhibit biosynthesis of CoQ.

CoQ has a complex structure that can accept or donate electrons in biochemical reactions. This ability makes it an essential coenzyme partner for a number of enzymes that store or release energy in biochemical reactions. All cells require CoQ to provide energy for metabolic processes. Heart tissues have a much greater energy demand and, hence, a much greater need for CoQ than most other tissues in the body. Thus, because of this great demand for energy, symptoms of CoQ deficiency are often related to the heart, primarily as congestive heart failure. It is ironic that statin drugs, which are medications prescribed to prevent coronary heart disease, can themselves cause heart disease by creating a deficiency of a biochemical essential for good heart health. Other important symptoms of CoQ deficiency are muscle pains, fatigue, and a general lack of energy.

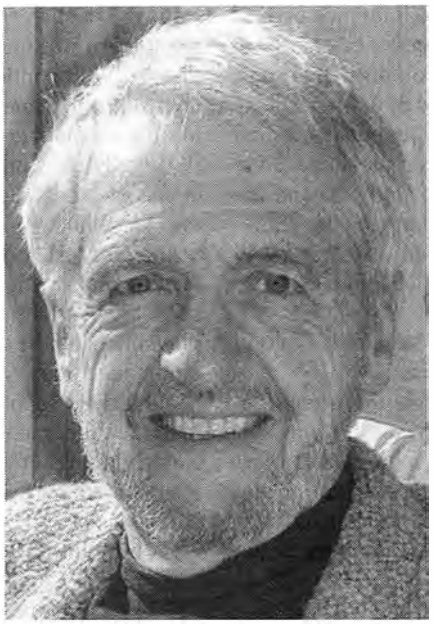
The New Cholesterol Guidelines

Proof of the fact that the medical establishment is fully committed to the cholesterol hypothesis is the publication of the "New Cholesterol Guidelines" for the nation's doctors by the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) in May of 2001. These guidelines are major clini-

cal practice guidelines for the prevention and management of high cholesterol in adults. The stated goals of the new guidelines are to reduce the prevalence of high blood cholesterol, better identify people at high risk, and reduce the risk of coronary heart disease.

The impetus for the guidelines was the fact that, despite the decades-long pursuit of the heart-healthy diet by many Americans, coronary heart disease had finally become the number one killer in the U.S., striking down about 500,000 people each year—primarily by heart attack. The guidelines lower the laboratory value for blood cholesterol that would trigger statin drug therapy, and modify conventional dietary recommendations to urge more rigorous reduction of dietary cholesterol and saturated fats.

NHLBI estimated in 2001 that, under the new guidelines, the number of Americans on low-saturated-fat, low-cholesterol dietary treatment would increase from about 52 million to about 65 million, and the number who are prescribed cholesterol-lowering drugs would increase from about 13 million to about 36 million. The guidelines advise physicians that, because Americans at high risk for a heart attack are too often not identified and, as a result, do not receive sufficiently aggressive treatment, cholesterol-lowering drugs should be employed when diet and exercise do not sufficiently lower blood cholesterol.



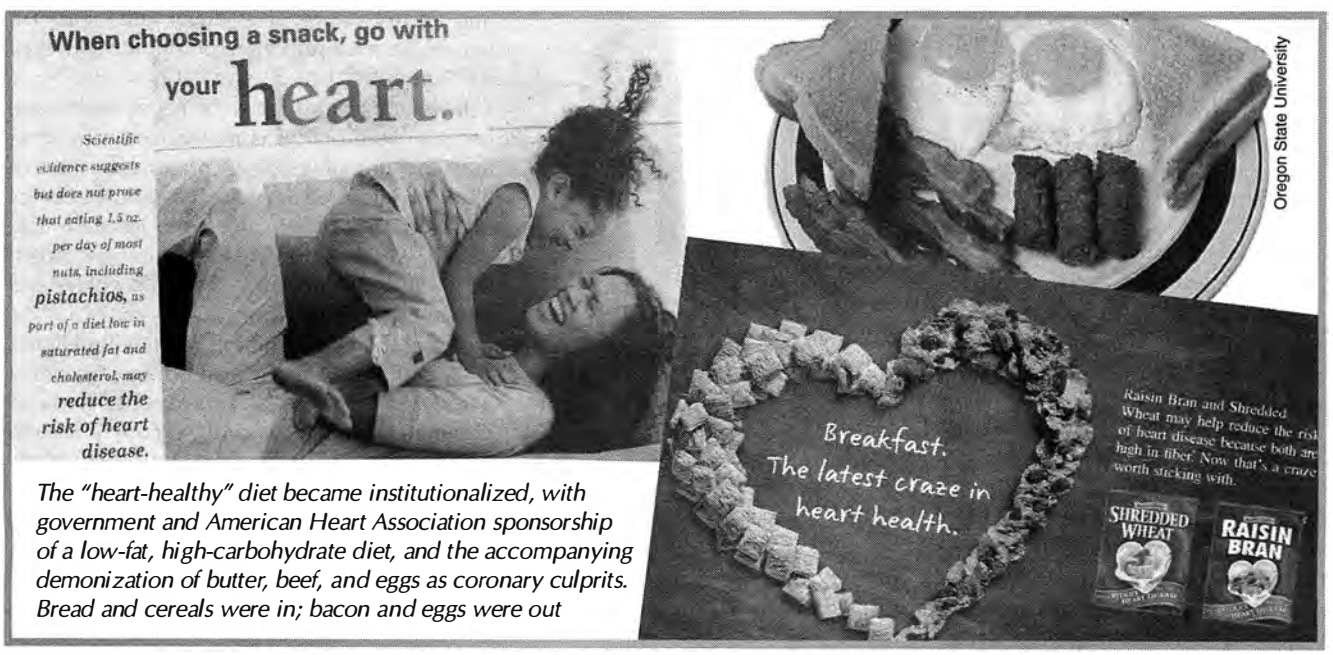
Courtesy of Uffe Ravnskov

Uffe Ravnskov, a Swedish physician, has challenged Keys's analysis, and calls the lipid-cholesterol hypothesis a fallacy. His research is summarized in The Cholesterol Myths: The Fallacy That Saturated Fat and Cholesterol Cause Heart Disease *(published by New Trends Publications, Washington, D.C.)*

These new guidelines were presented to the public as if written and promulgated by NIH, a branch of the U.S. Government. But the facts are that the new guidelines were approved and issued by the National Cholesterol Education Program (NCEP), a nongovernmental organization operating under the aegis of, and with the support of, the NHLBI. A subgroup of the NCEP, called the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, actually wrote the new guidelines. It is noteworthy that the Expert Panel was composed primarily of experts from the drug industry.

Despite the fact that the process by which the guidelines were written may seem proper to most people, it was not. This process bypassed government codes aimed at ensuring that standards, guidance documents, and rules approved and promulgated by government agencies have been considered in open meetings and are free of bias. The approach used by NCEP suggests a strategy in which special interests used the stature and credibility of a government agency to promote faulty science that supports the sale of low-fat, low-cholesterol foods and certain prescription drugs. It is ethically wrong and seemingly illegal for a private group, ostensibly sponsored by the federal government, to be given the responsibility for formulating and approving guidelines that will become standards of good practice for all of the physicians in our country.

Within days of the publication of the 2001 guidelines, pub-

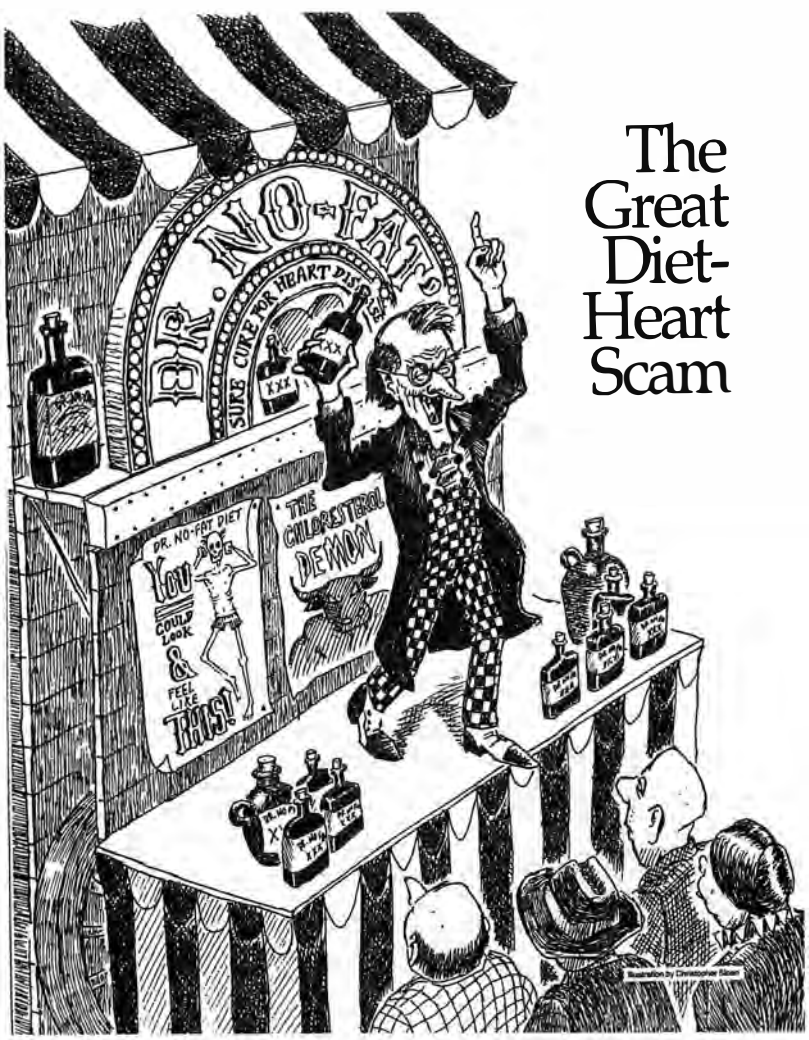


The "heart-healthy" diet became institutionalized, with government and American Heart Association sponsorship of a low-fat, high-carbohydrate diet, and the accompanying demonization of butter, beef, and eggs as coronary culprits. Bread and cereals were in; bacon and eggs were out

lic interest groups raised questions about the influence of drug manufacturers. It was estimated that the guidelines could put about 18 percent of the entire U.S. population on statin drugs, which would have the effect of tripling sales of these products to nearly $30 billion per year. Aside from a potential windfall for drug companies, a grave concern is for the impact the guidelines will have on both the practice of medicine and the long-term health of Americans. Will physicians see the guidelines as the product of the latest government research? Will they prescribe more statin drugs and tell their patients to try harder to follow a low-saturated-fat, low-cholesterol diet? Will lawyers and judges use these guidelines as standards of good practice in legal controversies?

Some answers are now forthcoming. Since the promulgation of the guidelines, skyrocketing sales of statin drug constitute very good evidence that the nation's medical professionals are responding to them. This increase in statin drug sales indicates that doctors are promoting the heart-healthy diet, increasing blood cholesterol testing, and prescribing statins. Thus, the folly of a half-century is continued and reinforced. But faulty science inevitably has its price. Heart disease will continue unabated, and better approaches to controlling coronary heart disease will very likely continue to be marginalized.

The "New Cholesterol Guidelines" ignore the adverse effects of excess dietary carbohydrates on heart health, despite the fact that, in reaching their conclusions, the authors acknowledged the fact that the 40-year use of the heart-healthy diet was accompanied by concurrent increases in the coronary heart disease that this particular diet was supposed to prevent. Then, in the face of these irrefutable facts, they recommended that Americans intensify their use of the heart-healthy diet. Such disregard for both facts and logic is not a rational outcome of scientific deliberation. When you see water running uphill, look for a pump!



The Great Diet-Heart Scam

Conditioned by the mass media and a cult of statistics, the public's view of cholesterol and fat is not more scientific than that of the audience of yesteryear for the snake-oil salesman.

What Do You Do Now?

As a beginning, accept the fact that your health is your personal responsibility. Do not assume, as many people do, that caring for your health is your doctor's task alone. Your doctor is concerned about your health, but you are only one of his many patients to whom he must devote his professional thoughts and concerns. He does not have time to be your alter ego, even if he could. Remember, no matter how much you depend on your doctor to provide you with good health, it is only you, not he, who will suffer the heart attack.

Make your doctor a partner in your health by becoming an informed health care consumer, and learn some basics of nutrition and its relationship to coronary heart disease. Reading and study will help you explain why an excess of glucose-releasing foods (sugar and starch) and an imbalance of essential fatty acids are two of the most important nutritional causes of modern nutritional diseases.

It is important for you to be informed, because your doctor is not an expert in nutrition and probably knows little more about it than an informed layman. His knowledge of nutrition most likely came from nutrition academia, which is the arbiter of nutrition knowledge and defender of the lipid-cholesterol hypothesis. Thus, your doctor may not be aware of the biochemistry presented in Figures 1, 2, and 3, and so, instead of recommending a low-carbohydrate diet, he will tell you to eliminate animal fats, and perhaps even red meat, as recommended by the "New Cholesterol Guidelines."

Along with your doctor, make your pharmacist a part of your health care team, especially if you are taking any prescription medications. As with nutrition, your doctor is not an expert in drug action. His knowledge of

drug action comes from the pharmaceutical salespeople who explain how a drug works and what its side effects are. However, drug companies are not required to warn doctors about depletion of nutrients by a drug, or to include this hazard on drug labels. Thus, deficiency-caused health problems are often misdiagnosed because most doctors are not sufficiently aware of such problems.

On the other hand, pharmacists are knowledgeable not only in mechanisms of drug action, but also in mechanisms of action of natural and synthetic nondrug chemicals, including vitamins, minerals, herbs, miscellaneous supplements, and a wide variety of substances not intended for human consumption. Your pharmacist is an indispensable member of your health care team who, if you are taking statin drugs, can advise you about their depletion of CoQ.

Granted, reading and study will take effort, but it will be worth it because it is your health and that of your loved ones you are protecting. Be assured that nutrition is not an esoteric discipline; no one has a monopoly on knowledge of nutritional science, and no one has a monopoly on the ability to understand why the human body is not a simple furnace that will thrive on any fuel. It is a living organism dependent on countless complex biochemical reactions created over millions of years by natural evolution. It requires its own special fuel, a diet composed of a proper balance of specific proteins, fats, and carbohydrates, plus a host of other nutrients.

Finally, if you already have heart disease or any of the other modern nutritional diseases, take comfort in the fact that the human body is a very forgiving creature and will respond favorably to good nutrition, even after decades of abuse. And keep in mind as you study and learn—there are no drugs that can cure a nutritional disease!

Recommended Reading

Robert C. Atkins, *Dr. Atkins' New Diet Revolution* (New York, N.Y.: Avon Books, Inc., 1999).

This book contains a wealth of information on the causes and dangers of obesity. It describes a dietary program for safely returning to normal weight and health.

Robert C. Atkins, *Vita-Nutrient Solution* (New York, N.Y.: Fireside, Simon & Schuster, 1999).

Aptly subtitled "Nature's Answer to Drugs," this book presents detailed information on the use of nutritional supplements in the treatment of many chronic illnesses.

Mary D. and Michael R. Eades, *Protein Power* (New York: Bantam Books, 1999).

This book is based on the Eades's long and successful medical practice specializing in weight loss and control using a 40:30:30 (carbohydrate: protein: fat) diet plan

Mary G. Enig, *Know Your Fats* (Silver Spring, Md.: Bethesda Press, 2000).

An important source of accurate nutritional information on fats, oils, and cholesterol, this book contains difficult-to-find information for saturated, trans, and unsaturated fat composition of several hundred foods.

Duane Graveline, *Lipitor, Thief of Memory: Statin Drugs and the Misguided War on Cholesterol* (Haverford, Penna.: Infinity Publishing, 2004).

The physician-author describes the devastating cognitive side effects of a statin drug that he suffered.

Kilmer and Martha McCully, *The Heart Revolution* (New York: HarperCollins Publishers, 1999).

This book describes the role of homocysteine in cardiovascular disease and how vitamins B6, B12, and folic acid prevent its damaging effects.

Michael T. Murray, *Encyclopedia of Nutritional Supplements* (Rocklin, Calif.: Prima Publishing, 1996).

This book contains a wealth of information, including deficiency symptoms, recommended dosages, uses, benefits, safety issues, and interactions, for many supplements.

Alice and Fred Ottoboni, *The Modern Nutritional Diseases (Heart Disease, Stroke, Type-2 Diabetes, Obesity, Cancer) and How to Prevent Them* (Sparks, Nev.: Vincente Books Inc., 2002).

Uffe Ravnskov, *The Cholesterol Myths: Exposing the Fallacy that Saturated Fat and Cholesterol Cause Heart Disease* (Washington, D.C.: NewTrends Publishing, Inc., 2000).

The physician-author explains the scientific facts concerning the true relationship between cholesterol and heart disease—essential for anyone taking statin drugs.

Ray Sahelian, *All About Coenzyme Q10* (Garden City Park, N.Y.: Avery Publishing Group, 1998).

This is an important and informative small book about this vital coenzyme inhibited by statins.

Barry Sears, *The Omega Rx Zone: The Miracle of New High-Dose Fish Oil* (New York: ReganBooks, HarperCollins Publishers, Inc., 2002).

This book explains in easy-to-read language the functions and importance of essential fatty acids.

Barry Sears, *The Anti-Aging Zone* (New York: ReganBooks, HarperCollins Publishers, Inc., 1999).

Sears discusses here the mechanisms of aging and how a 40:30:30 (carbohydrate: protein: fat) diet affords anti-aging benefits.

Diana Schwartzbein, *The Schwartzbein Principle* (Deerfield Beach, Fla.: Health Communication, Inc., 1999).

This book presents numerous case histories in which chronic debilitating diseases were controlled or reversed by diet and lifestyle changes.

Artemis Simopoulos and Jo Robinson, *The Omega Diet* (New York: HarperCollins Publishers, Inc., 1999).

This book is valuable for an understanding of the tremendously important role the essential fatty acids play in all phases of life.

Technical References

J.P. Bantle et al.,"Effects of Dietary Fructose on Plasma Lipid in Healthy Subjects," *Am. J. Clin. Nutr.*, Vol. 72, No. 5, pp. 1128-34, (2000).

M. Cesari, B.W.H.J. Penninx, A.B. Newman, et al. "Inflammatory Markers and the Onset of Cardiovascular Events: Results of the Health ABC study," *Circulation*, Vol. 108, pp. 2317-2322 (2003).

M.G. Enig, "More on Coronary Heart Disease: The Dietary Sense and Nonsense," *N. Engl. J. Med.*, Vol. 331, No. 9, p. 615 (1994).

P.H. Langsjoen and A.M. Langsjoen, "The Clinical Use of HMG CoA-reductase Inhibitors and the Associated Depletion of Coenzyme Q10: A review of Animal and Human Publications," *BioFactors* Vol. 18, pp. 101-11 (2003).

_____, "Overview of the Use of CoQ10 in Cardiovascular Disease," *BioFactors*, Vol. 9, Nos. 2-4, pp. 273-284 (1999).

A.J. Olszewski and K.S. McCully, "Fish Oil Decreases Serum Homocysteine in Hyperlipemic Men," *Coron. Art. Dis.*, Vol. 4, pp. 53-60 (1993).

A.J. Olszewski, W.B. Szostak, M. Bialkowska, S. Rudnicki, and K.S. McCully, "Reduction of Plasma Lipid and Homocysteine Levels by Pyridoxine, Folate, Cobalamin, Choline, Riboflavin, and Troxerutin in Atherosclerosis," *Atherosclerosis*, Vol. 75, pp. 1-9 (1989).

M. Rauchhaus, A.L. Clark, W. Doehner, et al. "The Relationship between Cholesterol and Survival in Patients with Chronic Heart Failure," *J. Am. Coll. Cardiol.*, Vol. 42, No. 11, pp. 1933-1940 (2003).

U. Ravnskov, "High Cholesterol May Protect against Infections and Atherosclerosis," *Q. J. Med.*, Vol. 96, pp. 927-34 (2003).

_____, "Statins As the New Aspirin: Conclusions from the Heart Protection Study Were Premature," *Brit. Med. J.*, Vol. 324, p. 789 (2002).

_____, "A Hypothesis Out-of-date: The Diet-heart Idea," *J. Clin. Epidemiol.*, Vol. 55, No. 11, pp. 1057-63 (2002). Same issue: "Dissent" by W.S.Weintraub and "Reply" by U. Ravnskov.

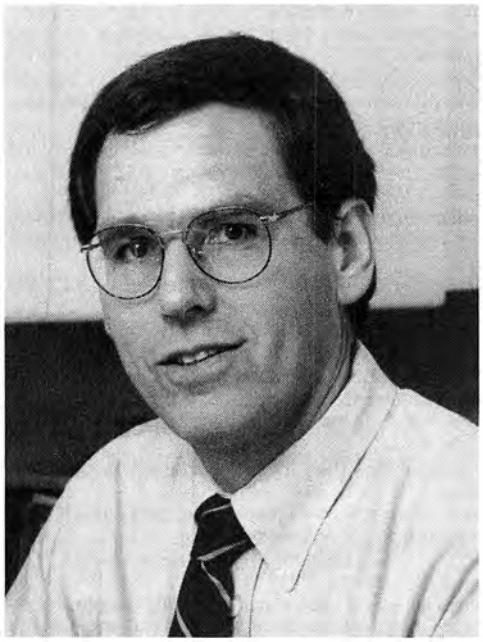
U. Ravnskov, C. Allan, D. Atrens, M.G. Enig, et al. "Studies of Dietary Fat and Heart Disease," *Science*, Vol. 295, pp. 1464-65 (2002).

U. Ravnskov and M.C. Sutter, "Aggressive Lipid-lowering Therapy and Regression of Coronary Atherom," *JAMA*, Vol. 292, p. 38, (2004).

M.C. Sutter, "Blood Cholesterol Is Not Causally Related to Atherosclerosis, *Cardiovasc. Res.*, Vol. 28, p. 575 (1994).

_____, "Assigning Causation in Disease: Beyond Koch's Postulates," *Persp. in Biol. and Med.*, Vol. 39, pp. 581-592 (1996).

E. Vos and S.C. Cunnane, "Alpha-linolenic Acid, Linoleic Acid, Coronary Artery Disease and Overall Mortality," *Am. J. Clin. Nutr., Vol. 77, pp. 521-2 (2003).*



John Abramson, M.D.

INTERVIEW WITH JOHN ABRAMSON, M.D.

'Cholesterol Is Not a Health Marker'

A physician and educator explains that the focus on cholesterol is driven by commercial interests, not health; it's where the money is to be made.

Question: From your research analysis, what do you see as the relationship of cholesterol to heart disease and overall mortality?

Data from the Framingham Heart Study were published in 1993 in the *Archives of Internal Medicine*. They show that cholesterol is positively correlated with overall mortality through age 40. There is no relationship between cholesterol and overall mortality between ages 50 and 70, and there's a negative relationship between cholesterol and mortality at age 80. So the lower the cholesterol, the higher the mortality at age 80.

Question: So, if we're talking about people over 50—

Once people reach 50, there's not a correlation between overall mortality and cholesterol. There is a correlation between mortality from heart disease and cholesterol until people reach age 70, and then the relationship goes away.

Question: So, there's a correlation between *heart disease mortality* and cholesterol up to age 70. . . .

There's no evidence that cholesterol increases the overall risk of mortality, once age 50 is reached. And no evidence that cholesterol increases the risk of heart disease mortality, once age 70 is reached.

Dr. Abramson is a Clinical Instructor in Primary Care at Harvard Medical School, and the author of Overdosed America: The Broken Promise of American Medicine, *published in September 2004 by HarperCollins.*

He was interviewed by Managing Editor Marjorie Mazel Hecht, November 2004.

Question: But for the people in between, what do you tell them? What does this mean for the people in their 40s, 50s, and 60s, who are told that they need a cholesterol-lowering drug?

There are two separate issues here. One is: What does the evidence show about the benefits of cholesterol lowering.

There is no evidence from randomized controlled studies, that lowering cholesterol with statin drugs is beneficial to women who don't have heart disease or diabetes. Similarly, there's no evidence from randomized controlled studies that lowering cholesterol for people over age 65, without heart disease or diabetes, is beneficial. But the 2001 Cholesterol Guidelines from the National Cholesterol Education Program, recommended an increase from 13 million to 36 million Americans taking statins. Most of that increase was for primary prevention. Most of those people don't have heart disease or diabetes.

Question: How do you define heart disease, just to be clear?

Having had a heart attack, or symptoms from blockage of the coronary arteries—angina.

Question: So, if you haven't had a heart attack, and there's no evidence of blockage of your arteries . . . if you are a woman, there is no evidence that you get a benefit from cholesterol-lowering with statin drugs. And for men, what would you say?

For men at elevated risk, there is evidence of benefit, of reduction of the risk of heart attack and cardiovascular mortality.

Question: How do you define an elevated risk?

The original studies included in the WOSCOP[1] looked at men with LDL-cholesterol levels averaging 192.[2] They lived in Western Scotland, which has among the highest rates of heart disease in the world. And then the other study that was included in the 2001 guidelines was the AFCAS/TexCAPS study,[3] which looked at lowering cholesterol in a broader population with an average LDL level of 150. And the difference in the results of those two studies is telling. In the WOSCOPS study, there was a 31 percent reduction in cardiovascular events and a 22 percent reduction in overall mortality, which just missed being statistically significant.

But in the AFCAPS study, the relative risk reduction in cardiovascular disease was 37 percent in the people who took the statin. But there was not a statistically significant reduction in cardiovascular mortality, and there were actually slightly more deaths overall in the people who took the statin than in the people who took the placebo. And the most important finding from this study is virtually unknown, which is, that there were equal numbers of serious illnesses in the people who took the statins and the people who took the placebo—serious illness being defined as something that causes hospitalization, death, or a new diagnosis of cancer.

So, in the AFCAPS study, it looks like you're trading cardiovascular diseases for other diseases, and not improving overall health.

The important issue here, is that if you go backwards, and apply the cholesterol guidelines for primary prevention, that were developed on the basis of the WOSCOPS and AFCAPS studies, about 85 percent of the men in the AFCAPS study qualify for statins based on the guidelines that were made using that study. But when you look at the overall benefit, you see that you're not saving any lives, and it looks like you're simply trading cardiovascular disease for other disease.

"Probably about 80 percent about what doctors and patients believe to be true about medical care is coming from commercial sources."

Question: So what did the statins do? Suppress the immune system?

We don't know. I wouldn't jump to a conclusion. I'd leave it a black box.

Question: But there are so many black boxes in this whole area.

Exactly. That's what I've been doing for the last three years—trying to recalculate, and figure out whether the cholesterol recommendations are based on good evidence or not. And I think as a clinician, somebody who comes in, and who fits the WOSCOP study—say a man comes in with an LDL of 192, I can say to him, "Look, if I treat 100 men like you with a statin drug, in two years, I will prevent one heart attack, and in 5 1/2 years, I will prevent one death. So, do you want to take a statin?" And the person can make his decision, yes or no. I'm not saying it's a foregone conclusion. Many people would want to take the statin, and others would choose not to. As long as the person understands the risks and benefits, I would support either decision.

But if I say to a person with 150 LDL, "If I treat 100 people like yourself with a statin, in 2 1/2 years we'll prevent one cardiovascular event, but it will be replaced by another serious illness, and there is no reduction in your overall risk of mortality," I doubt that a lot of people would opt for the statin.

An additional problem is that the National Cholesterol Education Program focussed virtually all our attention on lowering cholesterol with drugs. Yet, we find out that exercise and diet are much more important in preventing heart disease and improving overall health. The important point is that when we talk about exercise, diet, not smoking, drinking in moderation, and maintaining a healthy body weight, those are very weak ways to lower cholesterol—they are not very effective at lowering cholesterol at all, but they are *very effective* ways to reduce our risk of heart disease, and to improve our overall health.

So, many people, even the most educated people and the best educated doctors, have been focussed so on cholesterol, that they think lifestyle changes are being recommended because they will lower cholesterol; but it's not lowering cholesterol that's the goal, it's improving health. And then when you go back to the original Framingham data, that we started the interview with, you see that cholesterol isn't the end-all and be-all.

In fact, there was a study published in the *Journal of the American Medical Association* about a month ago that looked at the results of following 7,300 women for 31 years, in Chicago, previously healthy women. It's like the Framingham Heart Study—women weren't included in the study if they had heart disease or major cardiogram changes. And it looked at the contribution of various risk factors to overall mortality: blood pressure, diabetes, smoking, cholesterol, race, and minor cardiogram changes. The contribution of cholesterol to overall mortality for these women was 0.00.

Question: So we have an area which people are very scared about, but which is a black box, still to me. We know certain things, but how do you explain this to the ordinary person?. . .

Well, I think it's pretty simple, that the information that's coming at doctors and patients about cholesterol, is getting pushed forward primarily by commercial interests for its commercial value. It's not about improving our health.

Question: It's pushing drugs—very high priced drugs.

High priced and potentially dangerous drugs.

Question: So, what would you recommend for someone who has high cholesterol, and who is at risk for, or already has a heart condition?

Let's separate the question: first, someone who has high cholesterol and is at risk for heart disease. In the new guidelines, that would be that they have two or more risk factors, that their chance of having heart disease in the next 10 years

is 10 to 20 percent, and their LDL-cholesterol is 130 and above, before July 2004 [when the new guidelines were adopted] or 100 or above after July 2004.

Let's separate it out for men and women, under and over 65. For women, there's no evidence that lowering their cholesterol with drugs is going to be beneficial. But there is very good evidence that exercising routinely, eating a healthy diet, not smoking, drinking in moderation, and maintaining a healthy body weight, reduces their risk of developing heart disease by 83 percent.

Now that's a headline, to me—an 83 percent reduction in risk of heart disease. Whereas the statin has zero percent reduction in heart disease. So, it's very clear to me what women should do.

For men who are at significant risk of heart disease, taking a statin may help to reduce the risk of heart disease, but it's very important to remember that *each* of the other lifestyle changes is probably more important than taking a statin, and combined, they are far more important.

For people over 65, who don't have heart disease or diabetes, we don't have significant evidence from randomized controlled studies that taking a statin drug decreases their risk of heart disease or their overall mortality rate. But we do have very good evidence—just recently a study published in JAMA [*Journal of the American Medical Association*], showing that elderly folks who exercise routinely, eat a Mediterranean-style diet, don't smoke, and drink in moderation, have only 35 percent the mortality rate of people who don't do those things.

So, those lifestyle issues are very important for those elderly folks. But taking a statin drug, we don't have evidence [that it decreases mortality]. We do have evidence, however, that people 70 or older, who take a statin drug, develop significantly more cancer.

Question: Why do you think there is such a difference between men and women under 65?

Well, women have much lower rates of heart disease prior to menopause and in the years immediately following menopause. So there's probably something that's protective about women's hormonal environment, that we don't quite understand, that makes women's heart disease different from men, until they get into older age. And it's not simply the estrogen and progesterone, because the HERS study[4] showed us that even though hormone replacement therapy reduces "bad" cholesterol and improves "good" cholesterol, it doesn't reduce the risk of heart disease.

Cholesterol is given far too much weight as a health marker. And the disparity in the HERS study, really points it out: that lowering "bad" cholesterol and increasing "good" cholesterol, doesn't necessarily improve the risk of heart disease. It's more complicated than that.

Cholesterol levels are what we call a surrogate end point. They are not a health marker. They are not a health outcome. But because the money is to be made in getting people to believe that lowering cholesterol is the important health outcome, that's what patients and doctors have become focussed on.

A really important study is the Lyon Diet Heart study—a randomized, controlled study—in which people who had heart attacks, were randomly assigned to eat a Mediterranean-style diet or a prudent post-heart-attack diet. The people who ate the Mediterranean diet had about a 70 percent reduction in their risk of heart disease, and about a 45 percent reduction in their death rate. So that's at least twice the benefit that we see patients, post-heart-attack treated with a statin (not that the two approaches can't be done at the same time). The important point here, is that the Mediterranean diet is very effective in preventing further heart disease and death, but it didn't lower people's cholesterol.

Question: The accompanying article by the Ottobonis [page 45], discusses how the intake of cholesterol in foods doesn't have a direct relationship to your body's cholesterol.

That's probably true, but type of food intake does have a big impact on your risk of heart disease.

Question: Yes, they also say that.

We've been sort of brainwashed into thinking that cholesterol is the most important health issue, but that's not true. That's where the money's to be made. . . .

The facts that we know are that Mediterranean diet works—and what about it works, I can't tell you. The jury is still out.

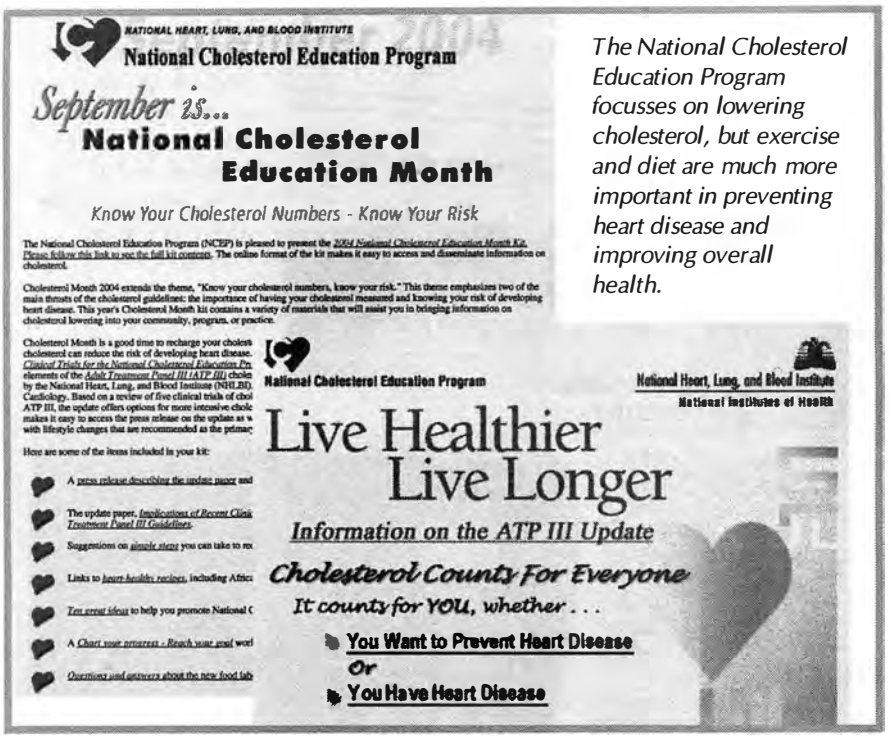
Question: Can you comment on the practice of using statistical data to determine medical diagnosis and treatment, instead of the traditional practice of an individual physician looking at an individual patient, and looking at the patient as a whole?

In the ideal, it would be a combination of the two. I think we have tipped way over into the biomedical model of medicine, where the unspoken underlying philosophy is that when we know more, the practice of medicine will be reduced to physics and chemistry.

Question: Or computer relationships. . . .

Yes, and that that will be good medicine. What is very clear to me, is that our health is 70 or 80 percent of the way we live our lives, and the environment that we live our lives in. And, as a physician, if I want to help people to make the changes that will be far more effective, overall, than medical interventions, then I need to have a relationship with people, and understand what their own sources of meaning, and their own values are, why they want to be healthy, to help them make changes that are sustained, that will have far more impact on their health than taking medicines.

What's happening, all the things that we've talked about so far, is that probably about 80 percent about what doctors and patients believe to be true about medical care, is coming from commercial sources. So that we mostly believe that it's the medical care that's going to protect our health, and not how we live our lives. Now, what that 80 percent does, is rely very heavily on statistics. And I think you have to look at two parts of the question you are asking. And on the downside of it, I'm in total agreement with you, that the person has to be—Sir William Osler, the first professor of medicine at Johns Hopkins, said it's more important to know what kind of



The National Cholesterol Education Program focusses on lowering cholesterol, but exercise and diet are much more important in preventing heart disease and improving overall health.

person has a disease, than what kind of disease the person has.

Question: I think there is another component that has come in, and that is the cost-cutting one, which is forcing some of these statistical changes and HMOs.

But if you really wanted to cut costs, you'd go the other way.

Question: What I'm saying is that that is what's being done, the computerization of medicine is used to cut costs. . . .

But I think it's the relentless dialectic of the marketplace.

Question: But the marketplace doesn't have a brain and doesn't make decisions. . . .

It just moves toward making more money.

Question: But it's the people who run it.

The length of visits has not gone down during the HMO period. In fact, the length of visits has actually gone up a minute or two. I entered private practice in 1982, and exited in 2002, 20 years later. So I saw these changes go on. Do you think when doctors were running around and collecting fees from each examining room, that they went slower, than when the HMO told them what they had to do?

Question: I think we had better medical care before the HMOs, put it that way.

Well, yes, but you can't blame it on the HMOs. . . . I think that the HMOs are just along for the ride. It's the commercial intrusion, and the HMOs are a part of that. But it's the commercialization of medical knowledge that really underlies the whole thing. . . . There are HMO excesses, I'm not disagreeing with what you are saying, but I think what's changed here is very important: that there's been a radical transformation in the purpose for which medical knowledge is developed and communicated. And that happened really in the 1990s.

In 1980, academic researchers turned up their noses at drug company money. President Reagan came in. Small government. Economic downturn. NIH money for clinical studies shrank, and academics had to turn to drug company money to do their research. But in 1991, still 80 percent of that commercially sponsored research was being done in universities, so the university researchers still had control of the study design, the data, and publication.

But then there was a radical transformation that proceeded after 1991. So that when you get to 2000, only 34 percent of that commercially sponsored research is being done at universities. The rest has been pulled out to for-profit research companies. The pharmaceutical companies now play the major role in designing studies. Most of the authors of the articles that are drug-company sponsored, don't get to see all the data from their own studies. They are only looking at the data that's getting parcelled out to them by the drug companies.

Question: That's a very disgusting situation, in terms of the health of the nation.

It's huge, it's huge. So authors themselves are not seeing the data. They are submitting articles to journals when the drug companies let them. The drug companies are more likely to withhold from publication studies that won't help their sales. Then when you submit the articles to journals, even the best journals that are peer-reviewed, the peer reviewers don't get to see the data that the authors didn't get to see. So peer reviewers can't help us in this situation.

Question: Isn't it only recently that authors are disclosing financial links to the drug industry?

They've been disclosed, but that doesn't help at all. The situation we're in right now, is that about 80 percent of our clinical research is coming from the drug companies, and even among the best of that research, the research that's selected to be in the Cochrane reviews, the odds are five times greater that commercially sponsored research will favor the drugs, than non-commercially sponsored research.

Question: So, really, we've lost our independent university-sponsored research capability in all this.

Right. Now it's 34 percent. But it's not just that it's only 34 percent. Drummond Rennie, the deputy editor of JAMA, said in 1999, that the academic institutions are so desperately trying to get that research money back, that it's a "race to the ethical bottom" among academic institutions. So now, they have

Advertisements for statin drugs are everywhere—on television, the Internet, and in print, reinforcing the idea that lower cholesterol is all-important for better health.

to compete with the standards that for-profit research companies have, or they won't even get their 34 percent.

So the bottom line is that the purpose for which medical knowledge is produced and disseminated is no longer to improve the health of the American people. It's a corporate investment, and it's designed and carried out and publicized with the idea of improving the corporate bottom line.

Question: I think that's a good summary of the situation, in which to view all the things we've discussed. That's the thesis of your book.

Yes. What I've done is to show how the magician does his tricks: How this happened, and how we believe that this is the right way to run a health care system. My book discusses how our health care system, which is spending $1.8 trillion ($500 billion of which is for unnecessary care, much of which is harmful to our health), how that can look to doctors and patients like the right way to practice medicine; that's really what the book is about.

Question: Meanwhile, if you look at things like infant mortality, the United States is sinking in this area. And if you look at other kinds of standard markers, where the U.S. once had a very fine health care system, leading in the world, now we are 14th or less among the nations of the world.

Out of 22 industrialized nations, we spend twice as much per capita, and we will live the shortest amount of time in good health.

Question: Something is wrong!

And infant mortality, which I go into in the book: the fact is that the concentration of neonatologists and neonatal beds for newborns, varies by a factor of four in the United States, with no benefit, once you have the minimum level. And when you compare the United States to other countries, we have twice as much neonatal intensive care capacity, but even looking at equivalent birth-weight babies, that doesn't buy us better survival statistics. So, what we're doing is spending twice as much on neo-natal intensive care, but less on the upstream solutions of prenatal care and preconception care, that would decrease the epidemic we have of low-birth-weight babies in relationship to the rest of the industrial world. That's the real problem.

And the *New England Journal of Medicine* editorial that went along with Elliott Fisher's article describing the variation of neonatologists by a factor of four, pointed out that one of the problems is that the neonatologists are supplied by a for-profit company that's traded on the New York Stock Exchange, that hires neonatologists, and they turn a profit of $50,000 per doctor that they hire! So, it's economically driven.

Question: From their standpoint. . . .

And from the hospital's standpoint. The hospital makes money on neo-natal beds. And what new mother is going say "no" to the doctor, when they say, "we think your baby would be safer if we transfer him to the intensive care unit"? Who's going to turn that down, and what HMO would dare turn that down?

There's a chapter in the book, "Follow the Money," that's about medical care being pushed into use by the financial incentives to the providers, rather than the health needs of the patients. The pressure comes from the business consequences to the suppliers of care.

Question: Let me get back to cholesterol: Why is the NIH, NHLBI so afraid to have an independent review of the cholesterol issues you raised?

Beats me. If I were head of the National Institutes of Health, I would say, "The question's been raised, there were financial conflicts, we believe in our data, therefore it's in everybody's interest to have guidelines that don't have a commercial shadow over them, so let's reevaluate them." That was not their response.

Question: Their response was really just to reiterate what they said to begin with. . . .

And to misinterpret what our argument was.

Question: Do you think that most physicians go along with the Guidelines because they have never seen anything else, they've never seen the criticism of the Guidelines?

Yes. And they have to, because they're at risk of getting sued if they don't. In other words: You come to me. Say you're a woman who has two risk factors for heart disease. Say you're over 55 and you have a low HDL. And I do the risk score, and the risk score comes out that there's a 10 to 20 percent risk of your developing heart disease over the next 10 years, and your LDL level is 105. According to the new guidelines, I should offer you the "therapeutic option"—that's their language; the new guidelines say that I should offer you the therapeutic option of a statin drug, right then at baseline, no longer tell you to go out and eat a good diet, etc.—right then, that I should offer you the therapeutic option of a statin. Now among women in that category, maybe there's going to be one heart attack out of—I'm going to make up a number—out of 1,000 women over the next few years. And if I have not offered that one out of a thousand women the therapeutic option of a statin, I can get sued. And the Guidelines are admissible in court as evidence.

Here's the important point: We were talking before about the challenge of physicians working in 15-minute time blocks to re-frame health for their patients as mostly determined by how they live their lives and the environment they are in, rather than prescribing medicines, and that is a challenge, that's true. But think how great the challenge if I'm a physician, and you come in, and I'm trying to explain to you that the Guidelines are overreading the data—as I believe, and others believe—and that I'm going to explain to you the Guidelines, and explain to you the counter-argument, so that you can make an informed decision about whether or not you want to take a statin drug. That's a time burden. That's an obstacle that I think is sinful, and a distraction to good medical care and to doctor-patient relationships. That's why the subtitle of my book is "The Broken Promise of American Medicine."

Question: It's a big problem; I understand that because many of my colleagues and friends are taking statin drugs, and they've been upset by what I have told them about cholesterol, because it challenges what they have been told by medical authorities. I think that the way the Ottobonis wrote their article is a good approach: They urge people to get more informed, and look at the evidence themselves.

I wrote an op-ed piece that was published in the *Los Angeles Times,* after the Guidelines came out in July, summarizing my criticism. A hospital in the Los Angeles area invited me to speak on the issue. Most of the people in the room were following me, but there was a mini-rebellion, from one or two guys, researchers, who couldn't stand it. And a professor from UCLA got up and said, "Look, I'm a guest here, but I've published hundreds of papers, and I know a lot about research, and what Dr. Abramson is telling you is so vanilla, in the middle of the road, just presenting the numbers that are in the studies that the Guidelines people are using. If I were presenting this information, I would be presenting a very different picture, which would be far more critical of the research upon which these guidelines are based."

So if we can somehow communicate this idea, that what I am telling you is totally middle-of-the-road. It is not biased, it is not overstated, it is just the studies that were used by the National Cholesterol Education Program. We're not even questioning the legitimacy of the studies (most of which were sponsored by drug companies) that were included in the Cholesterol Guidelines. I know a lot about the problems with the way that the Vioxx and Celebrex research data were misrepresented in JAMA and the *New England Journal of Medicine.* I haven't done that with the cholesterol studies. I'm just saying: "I'll take your studies at face value. You've misinterpreted them. You've misrepresented them."

Question: Well, it's a very political issue, and an important issue, especially as people get older.

Absolutely. It goes to the heart of a functioning democracy. Have you seen Philip Kitcher's book, *Science, Truth, and Democracy?* It's a philosophical book, but his argument is that at bottom, these are political issues. It's not science, but it's the political context in which science occurs. It's just like corporate behavior is politics.

Question: Science is politics. . . and science should be truth. We aim for printing the truth, not what's popular opinion.

Well, I think there's a philosophical problem with that, and here I'll paraphrase the doctor appointed by President Bush to be the head of his bioethics commission, Leon Kass, who I think makes a very important point, and I don't say this at all facetiously. He says that the kinds of truths that science can discover, are different from the kinds of truths that emanate from our values. And that we need to be clear about what our values are, if we are going to be able to use scientific truths in the service of humanity.

Question: What is he talking about? People's religious values?

In the context that we're talking, the moral question is, what do we think ought to be the function of the health care system? Ought it to be, to improve Americans' health most effectively and efficiently, or ought it to be to support a marketplace, whose product is health care?

Question: I certainly go with the former. . . .

I do too, but our current Administration seems more interested in the latter.

Question: That's a real problem, with this Administration, but that is a whole other issue.

I think that this question of values, of defining your values and knowing what your target is, is important. I think that one

Philip Ulanowsky/EIRNS

"One of the biggest health care emergencies in the United States is the lack of universal health insurance. Eighteen thousand Americans die each year because they don't have health insurance."

of the biggest health care emergencies in the United States, is the lack of universal health insurance. Eighteen thousand Americans die each year because they don't have health insurance. That's like a 9/11 every two months. I've got a paper coming out with a health policy colleague, called "When Health Policy Is the Problem." And what we are saying, is that health policy is in the way of solving this problem. If you believe that there should be universal health insurance, stop doing pilot projects, stop doing studies that show this and that, and implement universal health care.

That's our problem. We're not implementing universal health care. Seventy-nine percent of Americans think we should have universal health care, and they are willing to pay higher taxes to get it. These are the moral issues in the United States, not whether there should be gay marriage or not.

Question: I agree. The economic issues are far more important, and the others were a diversion. . . .

One final question on cholesterol: How did you get involved with this issue?

I was very fortunate to have the opportunity to do a two-year Robert Wood Johnson Fellowship, after finishing my residency in family medicine. During that time I studied epidemiology, research design, and health care delivery. I thought I was headed for a career in academic medicine—teaching in a family practice department in a university hospital. But watching my mentor work, I realized that family physicians in academic medical centers remain low doctors on the totem pole. Watching the difficulties he encountered on a daily basis, I decided that I could be most helpful by becoming a full-time clinician. So, I went into private practice. Toward the end of my 20 years in practice, I saw the commercial intrusion into the medical care that I was practicing, and that was being practiced on my patients by other doctors, growing exponentially.

I started to use the skills I had learned as a Robert Wood Johnson fellow, to research the research. The first major issue I sank my teeth into was Celebrex and Vioxx, and when I realized—this is in September 2001—how misleading the two articles about Vioxx in the *New England Journal of Medicine* were, and an article in the American Medical Association *Journal* about Celebrex, how they had misrepresented the data from the companies' own studies, I realized that we had crossed a line, where our most respected medical journals could no longer be trusted. I felt compelled to figure out how our medical knowledge was being corrupted by commercial influence and to tell the story—to patients and doctors.

So, I started to write a book documenting the extent and consequences of the commercial influence in our medical knowledge. I spent six months analyzing Celebrex and Vioxx data. The next thing I got into was the 2001 Cholesterol Guidelines, and the deceptions in that. For example, they say that there's evidence that statins help women for primary prevention (without heart disease or diabetes), and they quote six studies. But none of the six studies provides significant evidence.

They say that there's evidence—they quote nine studies—that statins help people over 65 for primary prevention, but none of the nine studies provides evidence to support their comment. About 200 pages after the claim about women, they say, evidence for women is "generally lacking"—that's in the eighth section—and that their recommendations for women are based on the extrapolation of data from men.

Question: Well, that's a big red flag.

That's when I sunk my teeth into this issue, when I realized that the Guidelines were a partisan argument for using more drugs, instead of a dispassionate analysis of the science. You'll see in my book, which went to bed in March, after two and a half years of writing, that I anticipated the July update of the Guidelines, because I talk about the studies—the ALLHAT study, the PROSPER study, the ASCOT study—and I bring them into the book as evidence that the 2001 Guidelines were wrong, and these studies show how wrong they were. And then the National Cholesterol Education Program uses the same studies to add millions more Americans to those already taking statins.

Notes

1. "Prevention of Coronary Heart Disease with Pravastin in Men with Hypercholesterolemia," *New England Journal of Medicine*, Vol. 333, pp. 1301-7 (1995).
2. LDL-cholesterol, commonly called "bad cholesterol," enters artery walls, causing plaque to build up that can block blood flow. HDL-cholesterol, commonly called "good cholesterol," can remove cholesterol from arterial walls, minimizing plaque formation.
3. "Primary Prevention of Acute Coronary Events with Lovastatin in Men and Women with Average Cholesterol Levels: Results of AFCAPS/TexCAPS," *Journal of the American Medical Association*, Vol. 279, pp. 1615-22 (1998).
4. HERS—the Heart and Estrogen/Progesterone Replacement Study.

INSIGHTS INTO SCIENTIFIC DISCOVERY

Grotefend's Decipherment of Old Persian

by Muriel Mirak-Weissbach

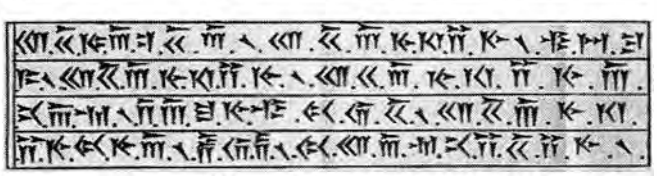
Working in the rich cultural environment of Göttingen University in the early 19th Century, Georg Friedrich Grotefend bet that he could decipher the cuneiform script of Old Persian—and succeeded in record time.

How does a scientific discovery occur? How is it that one individual succeeds in cracking a problem which had been nothing but a stubborn, hardened nut for those coming before him? Human history is full of such accounts; indeed, the individual's discovery of universal principles is the red thread which winds throughout the history of man's successive breakthroughs, whereby he masters those universal principles, and thus participates in the ongoing process of creation.

One of the most intriguing examples of creative break-

Iran Chamber of Commerce

Georg Friedrich Grotefend (1775-1835), with inscriptions he deciphered from Persepolis, capital of the ancient Persian Empire. At left are the ruins of the Gate of Xerxes, at Persepolis.



throughs is given us in the area of philology, specifically, the decipherment of "lost" languages. The case of Jean François Champollion's decipherment of the Egyptian hieroglyphics, is exemplary: The young French philologist unlocked the secrets of a script theretofore considered a hermetic, symbolic code used by a domineering priesthood to control an ignorant, servile population. Through his decipherment of what were considered secret symbolic images, Champollion showed that it was, instead, a highly developed script, used to communicate important ideas in science, poetry, law, and so on, in use among a highly literate population. Thus, Champollion's discovery was not only a "technical" achievement, like the cracking of a code; it provided the key to unlocking the gates which had been closed on an entire area of the ancient world. The decipherment of hieroglyphics (and the corresponding hieratic and demotic scripts) made it possible for the modern world to explore the great accomplishments of ancient Egyptian civilization, to learn about its astronomy, geometry, art, architecture, religious beliefs, philosophy, agriculture, industry, navigations, and relations with other cultures. Most important among these relationships was that with ancient Greek civilization, which was nurtured in the shadows of the great pyramids of Giza.[1]

A similar great achievement is ascribed to Georg Friedrich Grotefend, the German philologist who first deciphered the Old Persian cuneiform script, which opened the way for the decipherment of other languages using the cuneiform script, like Babylonian-Assyrian (Akkadian), and Babylonian proper.

The process leading to

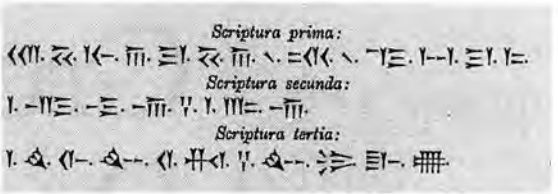
Figure 1
GROTEFEND'S THREE TYPES OF CUNEIFORM SCRIPT

Grotefend identified three different types of script in cuneiform, which he called the first, second, and third types. He gave the examples shown in (a).

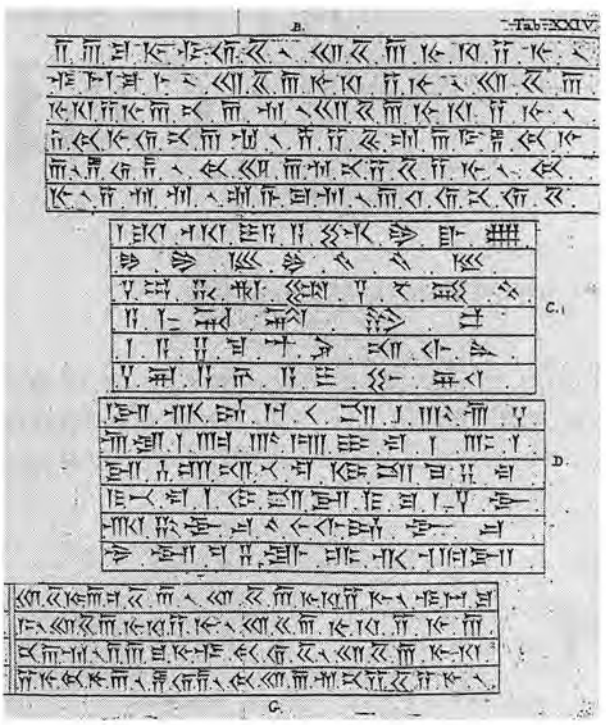
Grotefend then wrote that Niebuhr's inscriptions given in (b), Table XXIV, B (top) and G (bottom), belong to the first type, D belongs to the second, and C belongs to the third. The reader can confirm this by comparing the scripts.

Depicted in (c) is the Old Persian alphabet. At bottom is text G, with Grotefend's phonetic transliteration, and translation into Latin.

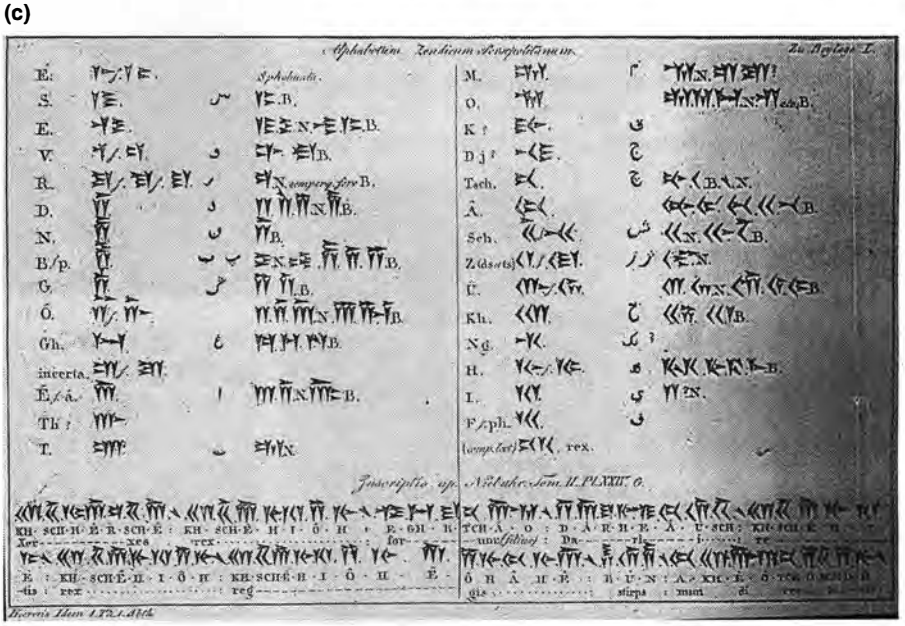
(a)



(b)

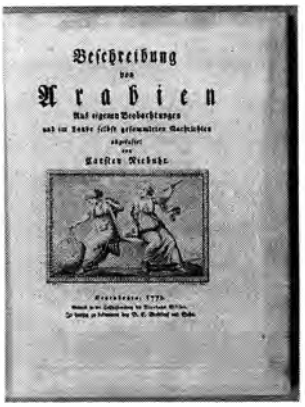


(c)



Source: Grotefend's "Erste Nachricht" for (a); Niebuhr's Table XXIV: B, C, D, and G for (b); and Niebuhr as reported by Heeren for (c).

Grotefend's breakthrough differed from that of Champollion, in that the German scholar was not a lifelong afficionado of the culture whose writing he sought to penetrate, as was Champollion. And yet, the process bears remarkable similarities to that of the young Frenchman. In both cases, there were forerunners who had contributed precious bits and pieces to the process, hypothesizing on how the script should be read (from right or left, from top or bottom, and so on), and what certain unique signs indicated. For example, in hieroglyphics, it was the Dane, George Zoega, who hypothesized correctly that signs enclosed in an oval form (called a "cartouche") were proper names, probably of pharoahs and/or gods. In the case of cuneiform, it was Olaf Gerhard Tychsen (1734-1815) who hypothesized that a single oblique wedge in the script might be a word divider. But in both cases, in the wake of this social process which stretched over centuries, it was the breakthrough made by the individual sovereign mind, which led to the definitive discovery. That is the fascinating process.



Carsten Niebuhr (1733-1815), who faithfully copied inscriptions from the ruins at Persepolis, which were later used by Grotefend. Above, is the frontispiece from Niebuhr's book, Descriptions of Travel to Arabia and Other Surrounding Lands.

As Grotefend himself relates, his decision to try to decipher cuneiform came about as a result of a bet. In his first paper announcing his breakthrough, which was delivered on Sept. 4, 1802, at Göttingen, he wrote:

> In the month of July [1802], as my friend Fiorillo, secretary of the Royal Library, argued with me during a walk, whether the content of documents could be determined, whose alphabet and language were totally unknown, I, who was already accustomed from an early age, to decipher coded sentences in my mother tongue, expressed the view that that certainly was possible. As he answered that I could prove this to him best, if, for example, I were to succeed in interpreting one of the cuneiforms, I promised him I would, if he would support me with the communication of all the relevant specialist literature. After that happened, I, with the help of my friend, tackled the script which the renowned O.G. Tychsen had tried to read, as the easiest of them all, and, fortune smiled upon me so much, that already a few weeks later, I was able to interpret the largest part of the inscriptions, by applying all the arts of decipherment. . . .[2]

What was known at the time, through the "relevant specialist literature"? Various documents had been disseminated, in the first step in the social process of discovery. The earliest knowledge of the curious cuneiform script reached Europe in the early 17th Century (1626), when Pietro della Valle published inscriptions which he had copied at Persepolis. Further copies of inscriptions were published by the jeweler, Jean Chardin (1643-1713), who provided examples from the Achaemenian palaces, especially the inscriptions from Naqsh-e-Rustam, which appeared in his *Voyages,* from 1711. Engelbert Kaempfer, a scientist and doctor who took part in the Swedish King Karl XI's trade expedition through Russia to Persia, visited Persepolis in 1686, and copied entire cuneiform inscriptions he found there, which he published in 1712. It was he who gave the curious script its name, *litterae cuneatae.* Later, the Dutchman, Cornelius de Bruin, in his *Reizen* (Travels) of 1714, hypothesized that the strange signs should be read horizontally, not vertically.

The first significant breakthrough came with the historic voyage undertaken by Carsten Niebuhr (1733-1815), in the Danish expedition of 1761, which took a group of enterprising scholars on a highly dangerous trek through Arabia and into Mesopotamia and Persia.[3] Niebuhr ended up being the only survivor of the historic mission commissioned by the Danish King Friedrich V. Niebuhr had come across the work of Kaempfer and de Bruin, but his own copies were more detailed and accurate. His groundbreaking *Reisebeschreibung nach Arabien und andern umliegenen Laendern* (Descriptions of Travel to Arabia and Other Surrounding Lands), was written between 1774 and 1778, and was used by Napoleon for his Egyptian expedition. In it, Niebuhr presented his copies of inscriptions from the ruins of the palace at Persepolis, which he visited in March, 1765, and which were later identified as related to Xerxes and Darius. The German scholar spent three weeks in Persepolis, and painstakingly recorded every detail of the ruins of the magnificent palaces there, and, most important, the inscriptions, which he copied faithfully.

Niebuhr noticed that there were three different types of script, which he carefully copied—see Figure 1(a): B and G; C, and D. He hypothesized that the script which seemed to have simpler signs, might be alphabetic, and might be read from left to right. He isolated the single signs and presented

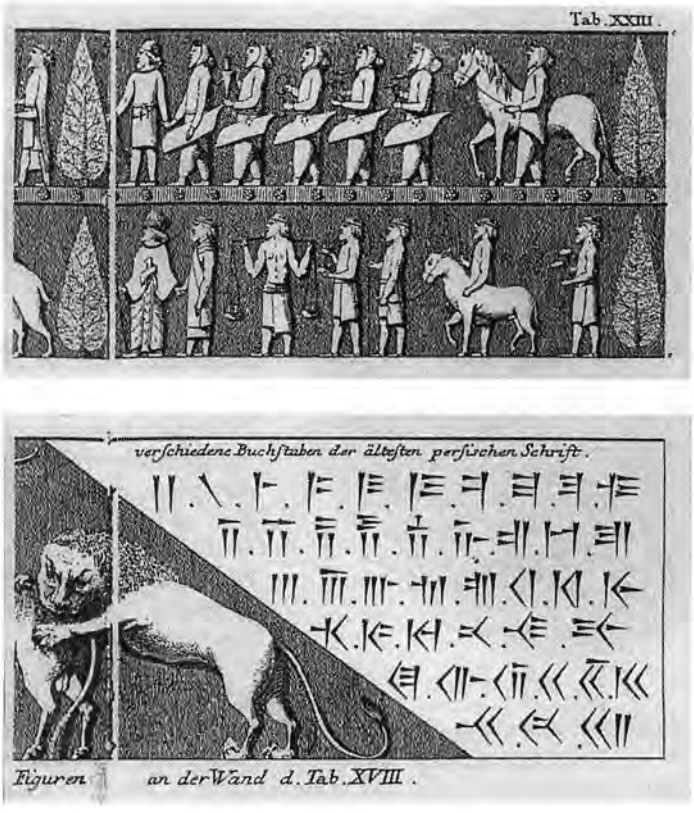


Figure 2
NIEBUHR'S CUNEIFORM ALPHABET
These are taken from Tables 23 and 18 of Niebuhr's book.

an alphabet. As it later turned out, 32 signs out of the 42-sign alphabet Niebuhr thought he had identified, were correct (Figure 2).

Another important find was recorded by the explorer Count Caylus (1762), who copied a four-language text from an alabaster vase belonging to King Xerxes, with specimens of what were later identified as Old Persian, Elamite, Babylonian, and Egyptian—see Figure 3: *2. Inscriptio vasis ap. Caylus Tom. V. Tab. XXX.* Since this was long before the decipherment of Egyptian hieroglyphics by Jean-François Champollion (in 1832), the fourth language, Egyptian, was of little help. No matter; what is important is that the English general consul in Baghdad, Claudius James Rich, sent copies of this text to his friend Grotefend, in Göttingen.

By the time Grotefend had the copies in his hands, a number of other scholars had hazarded certain hypotheses about the script. Olaf Gerhard Tychsen, a professor in Halle and Rostock, not only had posited the existence of three different languages in the three scripts, but, as mentioned above, also had identified the systematically recurring oblique wedge sign as a word divider. The Danish academician, Friedrich Christian Karl Heinrich Münter (1761-1830), who studied at Göttingen, suggested that the texts came from the Old Persian-era kings of the Achaemenian Empire, which would date them at about 550 B.C. Although Münter was wrong in supposing the second and third texts to be Pehlavi (Middle Persian) and Parsi (early New Persian), respectively, he was right in identifying the first script as Old Persian. He, too, saw the first as alphabetic, and proposed that the second and third were syllabic and ideographic, respectively. He also assumed that all three texts contained the same message.

A very important contribution to Grotefend's deciphering had been made by the Parisian, Abraham Hyacinthe Anquetil-Duperron (1731-1805), who had undertaken intensive studies in India with the last followers of Zarathustra (or Zoroaster), who had founded (ca. 500 B.C.) the religion named after him. Many of these Zoroastrians had fled to India after the Arab conquest of Iran, and had preserved the teachings and holy texts of what was known as the *Zend-Avesta.* Anquetil-Duperron studied the language of the *Zend-Avesta* under the Parsee teachers, and later brought an original of it back with him to Europe, together with a translation in New Persian, which had been dictated to him by a priest named Destur Darab. Although none of this was in cuneiform, the translation did contain the proper names in Persian. This was crucial, because they were otherwise known in Europe only through Greek references.

So, with this set of documents, facts, and hypotheses—and with no knowledge of any ancient languages of the region—Grotefend went to work. He faced a nested series of unknowns, which seemed to define the task as impossible. First, he had to deal with the fact that the existing copies of texts showed three, apparently different scripts. This posed two questions: What language or languages did they belong to; and, were the scripts alphabetic, syllabic, or ideographic; that is, were the signs symbols of single sounds, of syllables, of entire words, or some combination of two or three?

After a careful examination of the texts, Grotefend laid out four findings regarding cuneiform in general: First, that "their figures are characters." This, he said he had to state explicitly, simply because there had been other wild ideas, that the marks were "merely decorations or even the work of worms and insects, or at most, numbers. . . ." Second, that "the three inscription types always correspond to a completely different alphabet and language." Here Grotefend illustrated the three different types of inscriptions from Persepolis (which Niebuhr had copied), with three types that appear on the vase of Caylus—Figures 1(b) and 3; also 1(a).

The third finding he presented was that "the figures of those inscriptions which I have resolved to interpret, do not represent words or syllables, as in Chinese and Japanese, but rather letters, as we have." To prove this hypothesis, Grotefend refers to the word divider, an oblique or, in one type, a horizontal wedge. (The reader can encircle the word dividers, and thus isolate the single words.) If the signs between the word dividers were syllables, then there would be some words

made of up to 10 syllables, which is not likely. He also notes that there are word endings, that is, groups of signs at the end of words, which have up to four elements; here, too, it is more likely that they are letters than syllables. He also notes that certain groups of signs recur, for example, the second and fourth groups in text B—Figure 1(b). If, he asks, the single signs stood for whole words, then, why would the same group of words be so often repeated, as they are, with only a few words in between? Finally, if one counts the different signs that appear, they add up to 40 in each inscription type, hardly sufficient for a syllabic or ideographic script, but perfectly suited to an alphabet.

The fourth finding is that "all the cuneiform inscriptions that I know, must always be read from left to right horizontally, not in columns from top to bottom, or alternatively, left to right and right to left." This results from careful examination of the texts, whereby it appears that when a word is broken at the end of a line, the right part of the word at the end of the top line is continued in the left part of the first element on the line beneath. This is apparent as soon as one identifies the same group of signs repeated in different parts of the text. By the same token, elements hypothesized as word endings always appear on the right side of the word: See Figure 1(b), script B, the last word in line 2 completed in line 3; also the last four characters of this latter word.

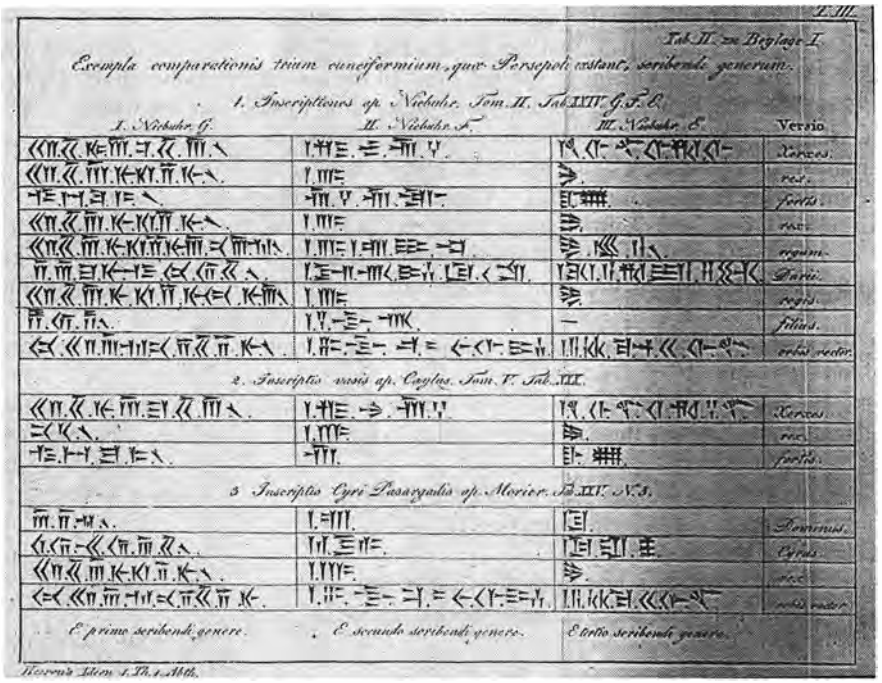


Figure 3

Examples of the three cuneiform scripts from three sources, as transcribed by Niebuhr (1, Table XXIV), Caylus (2, Table XXX), and Morier (3 Table XXV), as reported in Heeren's Ideen.

So much for the findings which emerged from Grotefend's initial examination of the texts. But how did he actually decipher them? Grotefend writes that he could, if so desired, simply publish the results of his decipherment, which would (at least to the experts) be self-proving. However, "in order at the same time to show the expert how someone ignorant of oriental languages was able to unveil the oldest documents of the Orient, I will make my decipherment method known." Recognizing the historic importance of the discovery, Grotefend said he decided to write up a report on "what my results are, what their nature is, and how they were obtained."

To make the process of Grotefend's discovery more transparent, each step, as he described it in his 1802 paper, will be illustrated, so that the reader can retrace his steps. First, Grotefend took two texts he had and compared them. These were Niebuhr's G and B, as shown in Figure 1(b), and de Sacy's inscription (in Greek, Middle Persian, and Parthian) of the Sassanid Kings Ardashir I and Shapur I. He noted in both that one word recurred several times, with some variation in the case endings, and that the word immediately before it, however, was different each time. (See words 2,4,5,6 in B and 2,4,5,7 in G.) He hypothesized that the recurring word meant "king" and that the preceding word was the proper name of a king. In one place, the word he took for "king" appeared twice together, once as such, and once with a prolonged ending of four characters. Grotefend hypothesized that the prolonged ending was a genitive plural, and that the phrase stood for the formula "king of kings," which, in de Sacy's translation, done in comparison with a Greek text, was the way two kings had designated themselves.

Then he saw that what he took for a proper name, which in text B appeared at the very beginning, appeared in text G, as the sixth word, after the "king of kings," with a small inflexional element, which he identified as the genitive, "son of." This, Grotefend hypothesized, must mean that one king was the father and one king was the son. Grotefend knew that the inscription copied by Niebuhr had come from Persepolis, and that it was located on a king's relief on a portal. To find what Persian kings there were that might fit the bill, he went to the writings of Herodotus. There he found several pairs: Cambyses was the son of Cyrus, and Xerxes was the son of Darius.[5] He ruled out the first pair, on grounds that the first letters would have to be the same in cuneiform, which they were not. He chose Darius and Xerxes.

He looked then at the *Zend-Avesta* holy script, to see how these names were written and pronounced: Dârheûsch and Khschhêrschê, in the German transliteration (probably in English: Darhoish and Khshhershe). He immediately saw the similarity of the first letters of what he took to be Xerxes's

name (Khsch) with those of the word he assumed was "king" *Khsch.* He consulted Anquetil's dictionary of Zend (Pahlevi and French), and saw, in fact, that the Zend word for "king" was *Khscheïô* (English *Khshayo*). On the basis of the sound values he had thus figured out for the name of what he took for Darius, he was able to identify the first and third letters of another word, the third word in text B, and in text G, as representing "e" and "r," and, again consulting Anquetil's dictionary, found the word *eghré* (later, corrected as *oghrem*), which meant "power." He posited that this, as an adjective, would modify the word "king," and yield the phrase "the strong king." (Later, this was refined to yield "the great king," but the meaning is essentially right—see Figure 1(b), B and G.

On the basis of what he had hypothesized thus far, Grotefend could propose the following translation for text G:

> Xerxes, the king, the strong (or great), the king of kings, of Darius, the king, the son, the ???.

And, he could translate a line from the Caylus vase inscription—Figure 3, part 2, in Latin at right: "Xerxes rex fortis."

> Xerxes, the strong king.

Continuing with his decipherment of a language which he did not know, Grotefend concentrated on the two texts, B and G, copied by Niebuhr. He saw that in text B, after the title for "king," there was a word (the seventh) which had an inflected ending typical of the genitive plural (as in "king of kings"). Entering the values he had acquired thus far from Dârheûsch, he posited *Dâhû,* which he thought was the name of a people. Again, consulting Anquetil, he saw that a similar word was identical with *daoi,* a name given by Herodotus for a Persian people.

Thus, for text B, he could propose the following translation:

> Darius, the strong king, the king of kings, the king of Dahu (of the Dahier). . . .

Then there is a word with the usual genitive singular ending, meaning "son of." But, after it, there is no mention of "king"! In short, here is a king, who is the son of someone who is *not* a king. In the text G, both father and son were kings. Again, referring back to the historian, Herodotus, Grotefend could hypothesize that this third proper name must be Hystaspes, who was the father of Darius, but not a king. This name Grotefend read as pronounced Gôshtâspâhê, and noted, "the title of king after this name is correctly missing."[6]

He then saw that in inscription G, the last word had an element in it which he thought was a combination of *akhé,* for "the world" and the word *shah,* for "king." He hypothesized that this word meant "master or ruler of the world." The word, again with reference to Anquetil's dictionary, seemed to identify Achaemenes, a family, according to Herodotus (I, 125), "from which the kings of Persia are descended." Grotefend thought that the last word meant "descendants," whereas, as it later emerged, it meant "the Achemenian."

Grotefend's version:

> Darius, the strong king, the king of kings, king of Dahu (of the Dahier), son of Hystaspes, Master (or ruler) of the world.

Correct version:

> Darius, the great king, the king of kings, the king of the lands (countries), son of Hystaspes, the Achemenian, (it is), who built this palace.

Grotefend's version:

> Xerxes, the strong king, the king of kings, son of Darius, the king. Master (or ruler) of all [Figure 1(c)].

Correct version:

> Xerxes, the great king, the king of kings, son of Darius, the Achemenian.

No matter as to details. In essence, Grotefend had untied the knot and deciphered decisive inscriptions from the Old Persian cuneiform, which laid the basis for the complete decipherment, not only of this language, but, later, of the Babylonian and other languages written in cuneiform.[7] As he stated at the end of his report, "I am ready to admit that I may have made mistakes in single items; but when the whole is considered, no one will be able to prove I was wrong."

Grotefend's discovery was first reported in 1802 at Göttingen, by Thomas Tychsen, and an article on it appeared in the *Göttingischen Gelehrten Anzeigen* (Göttingen Scholars' Report), 1802-1803, and later in a report by A.H.L. Heeren in his *Ideen ueber die Politik, den Verkehr und den Handel der vornehmsten Voelker der alten Welt* (Ideas on the Politics, Travel, and Trade of the Most Distinguished Peoples of the Ancient World), published in Göttingen in 1805 and 1817. Grotefend's own report on his discovery, the *Praevia de cuneatis quas vocant inscriptionbus Persepolitanis legendis et explicandis relatio* (Interim Report on the Reading and Explanation of the So-called Cuneifrom Inscriptions from Persepolis) was first published only 90 years later, in 1893! It had been found by the Latinist Wilhelm Meyer in Göttingen. In 1972, this was reprinted, but only in 1974 was Grotefend's original manuscript found among his papers, by Göttingen professor R. Borger. Borger published the first German translation of the Latin text in 1975, in a book celebrating the 200th anniversary of Grotefend's birth, which is, unfortunately, already a collector's item. In 1832, the year of Champollion's death, Grotefend wrote four further articles on "new attempts to decipher cuneiform." He entered in his notes: "The early death of Champollion moved me to collect my remarks on cuneiform, before death might surprise me too, and render [these remarks] lost to the world."

Once Grotefend had made his breakthrough, the way was paved for others to fill out the picture, and to decipher

The Sassanid Kings Ardashir I (right) and Shapur I, as depicted in gold coins. Both reigned in the 3rd Century A.D. Grotefend made use of inscriptions from their reigns in Greek, Middle Persian, and Parthian.

cuneiform inscriptions representing languages other than Old Persian. The Danish professor Rasmus Christian Rask (1787-1832), who was a co-founder of the discipline of comparative philology (with Franz Bopp and Jacob Grimm), was able to correct Grotefend's phonetical rendition of the plural ending, "king of kings," by making a comparison with Germanic languages, which he had mastered. Rask travelled to India in 1820-1822, where he studied Zoroastrianism with the Parsees. He was able to show the relationship between the language of the inscriptions deciphered by Grotefend, with the *Zend-Avesta,* and with old Indian languages.

Another contribution to decipherment came from Henry Creswick Rawlinson (1810-1895), a British intelligence officer in the East India Company, who was schooled in Oriental languages (he knew Arabic, Persian, and Hindu), and was intrigued by cuneiform script. Rawlinson went to extraordinary lengths to procure copies of cuneiform inscriptions which were carved in stone, some at a height of 3,200 meters. Rawlinson's copies of reliefs in Behistun turned out to contain the story of Darius in the three languages used at court: Old Persian, Elamite, and Babylonian. By referring to Herodotus, Rawlinson was able to decipher more proper names, and, through comparisons with Avestic and Sanskrit, he managed to decipher 200 lines from Behistun.

What emerged as a result of their work, and that of their successors, is, that several languages were written in these scripts. The origins lay in Mesopotamia, modern-day Iraq, where the Sumerian and Babylonian-Assyrian (also known as Akkadian) cultures thrived, and spread both eastwards and westwards. In the east was the civilization of Elam, in modern-day Iran, with its capital at Susa, which had links to Sumerian and Babylonian cultures. Elam adopted the cuneiform script as well as the Akkadian language, but then later used cuneiform for its own Elamite language. When the Persians arrived in Iran around 1000 B.C., they maintained the Elamite administration and language. Later, however, Darius, called for the development of an independent script for new Elamite, which became the language of the Persian Empire, thus explaining the second of the reported scripts.

The third was Babylonian proper. The kingdom of the Chaldeans was conquered by Cyrus the Great in 529 B.C., and became part of the Persian Empire, whereby Babylonian became a third language of the empire. Further adaptations of the scripts to different languages contributed to greatly complicating the task of decipherment.

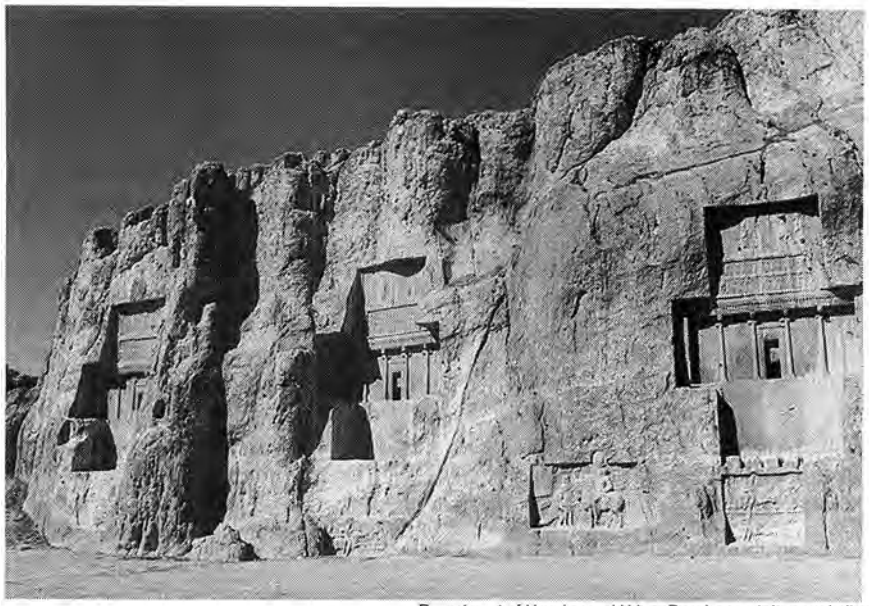
The Miracle of Göttingen

The story about Grotefend's famous bet has been retold many times, so much so, that the enormity of his breakthrough is often belittled: "Oh, he was a clever guy, good at solving puzzles, and he had a stroke of luck"—this is the basic line. Nothing could be further from the truth. Grotefend was not an expert in Oriental languages, which he had not yet studied; but he was a genius, and, not by accident, he was part of the extraordinarily creative environment of Göttingen. In fact, his achievement can rightly be called one of the many miracles of Göttingen.

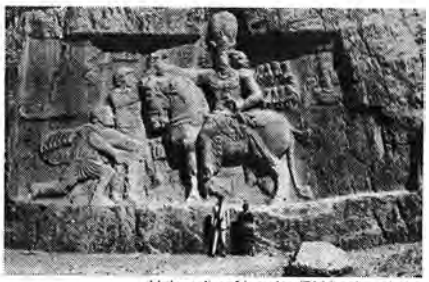
Göttingen was the academy which the great Gottfried Leibniz proposed: an institution of learning, research, and teaching based on the Platonic method, as developed by Leibniz, and dedicated to the progress of knowledge, in the service of mankind and the common good. In his proposal for a German academy,[8] Leibniz presented the purpose of such an academy as an expression of one's faith, hope in the future, and love of God, through the discovery and understanding of all the wonderful harmonies of His universe, whether expressed in the physical laws of the universe, the beauty of nature in all its forms, or the perfection of geometry; or whether expressed in the fantastic achievements of God's highest creature, man, through the history of his development and perfection of language, philosophy, religion, history, and the natural sciences. In Leibniz's conception, none of this was to remain purely theoretical, but was all oriented to his continuing commitment to improve the lot of mankind, from scholars to the poor, by applying the genial discoveries of great minds to the invention of new technologies and productive methods, all consecrated to the common good.

Leibniz's spirit breathed life into Göttingen, when it was founded according to a plan drafted by Hannover court counsellor, A.D. Gruber, who had succeeded Leibniz as librarian and historiographer of the House of Braunschweig-Lueneburg. And it was Queen Sophie, Leibniz's student, who sponsored the project.

Privy Councillor Gerlach Adolph von Münchhausen, who had studied at Jena, Halle, and Utrecht (1707-1711), received the commission to establish the institution at Göttingen, and did so, in 1737, by gathering there the best professors he could find, and offering them not only remunerative salaries, but total academic freedom—freedom from any kind of censorship. Münchhausen began by recruiting Albrecht Haller, the scholar and poet, who, beginning in 1747, published the famous *Göttingenischen Gelehrten Anzeigen* (Göttingen Scholars' Report), the scholarly journal



Department of Housing and Urban Development, Iran, website



University of London/Birkbeck website

The ancient capital of Persepolis, located 40 miles northeast of the present-day Shiraz, was built by Darius and his son Xerxes I, in the 6th Century B.C. This cliff of bas reliefs north of Persepolis was executed for the Sassanid King Shapur I (241-271 A.D.). The detail is of the bas relief at bottom right of the cliff, showing King Shapur receiving homage from a Roman emperor he captured in battle.

which was to make Göttingen's breakthroughs known throughout the educated community. Haller, who had studied in Leyden, set about improving the famous anatomy building at Göttingen (where anatomy provided the foundation of medicine), as well as improving the botanical gardens there. Haller also laid the basis for the disciplines of physiology and psychiatry at Göttingen.

Another great mind attracted to Göttingen was Johannes Matthias Gesner, rector of the Thomasschule at Leipzig, where he had been friends with Johann Sebastian Bach. Gesner liberated the study of philology from the bounds of theology (up to that time, ancient languages had been studied through the Old Testament), and vitalized language-teaching by presenting the old texts themselves, instead of dry grammars. In Leibnizian spirit, Gesner believed that such philological studies should serve to enhance one's understanding and use of the mother tongue, and demanded that one "recast the masterworks of the ancients through translation."

Münchhausen established the new Göttingen Library, in true Leibnizian tradition, by collecting the great works of past centuries, representing the entire process of the progress of science, and by making works available through a lending library. Münchhausen also founded another institution at Göttingen, the Gesellschaft der Wissenschaften (Society of Sciences), where professors not only taught, but conducted independent, original research. It was here that Wilhelm von Humboldt, as a student, developed his idea of a new German university: a new society of sciences, encompassing historical/philological and mathematical/natural sciences. When this was founded in 1751, Haller was its first president, and became director in 1753 of the Gelehrten Anzeigen.

In the latter half of the 18th Century, Göttingen excelled in the study of law and history; and geography, under the direction of Johann Michael Frantz, became an important discipline, which investigated "the natural composition of the region, and the mode of living of man," that is, the relationship of man to his environment, as discovered through philology, history, and science. The physical sciences were paramount in Göttingen, as exemplified by the work of mathematician Tobias Mayer, director of the observatory and discoverer of the theory of terrestrial magnetism. By 1770, Göttingen was the top institution of learning in Germany.

Münchhausen's successor, Christian Gottlieb Heyne (1729-1812), came to Göttingen in 1763, at the age of 34. There he realized the importance of study of the Classics, and dedicated himself to making this the basis for educating the individual. Wilhelm von Humboldt was a student at Heyne's lectures, prior to his collaboration with Goethe and Schiller, and the launching of the German Classical Period. Heyne further expanded the library, and reorganized the Society of Sciences. He became Professor of Classical Philology and the director of the university library in 1763. In 1770, he was elected Secretary of the Society of Sciences and the director of the Göttingenschen Gelehrten Anzeigen.

After the ravages of the French Revolution and the Napoleonic wars, Göttingen continued to grow in all fields, including philology, where great scholars like Karl Otfried Mueller, Franz Bopp, and the Grimm brothers developed comparative philology.

At the time of Grotefend's activity in Göttingen, which began in 1795, among the great scholars who taught there were: natural science researcher Friedrich Blumenbach; classical philologist Heyne; mathematician Abraham Gotthelf Kästner; physicist, philosopher, and writer Georg Christian Lichtenberg; expert in state law Johann Stefan Puetter; surgeon August Gottlob Richter; and historian August Ludwig Schloezer.

When Grotefend was elected as a corresponding member of the Society of Sciences in Göttingen in 1848, among the signers of the protocol was the great mathematician, Carl Friedrich Gauss, the most brilliant light of Göttingen. Göttingen was the place where all the branches of knowledge flourished; it was the throbbing heart of a social and intellectual process which developed, grew, and produced great ideas and discoveries, because of the fully integrated Leibnizian approach to knowl-

Gottfried Wilhelm Leibniz (1646-1716) inspired the founding of Göttingen University, with his 1671 work, "Foundations of a Memorandum on the Establishment of a Society for the Promotion of Arts and Sciences in Germany." His aim was to improve the condition of mankind, by applying discoveries to new technologies and production. Below, the library hall at Göttingen University, from an engraving by Georg Daniel Heumann, 1747.

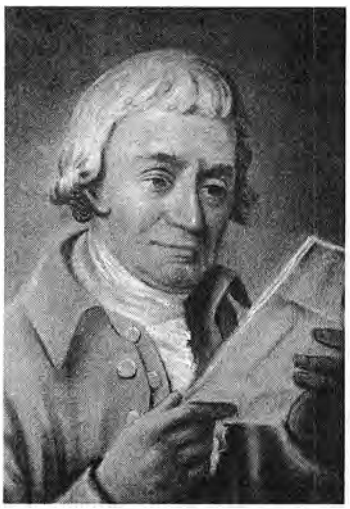
Göttingen University

edge. Certainly, there were separate faculties and departments, some newly established in Germany, like the Departments of Gynecology and Anatomy, and the famous botanic gardens. But the decisive factor was the methodological approach which characterized the efforts of all, professors and students, at the various institutions. This approach was Leibnizian *par excellence:* no separation of disciplines, no compartmentalized knowledge, and above all, no differentiation in the *method* of scientific inquiry, no matter what the *subject matter.* As Georg Christian Lichtenberg wrote of the physics experiments he conducted there: "When one teaches men *how* they should think, and not always *what* they should think, then even misunderstandings will be prevented. It is a kind of initiation into the mysteries of mankind."[9]

Göttingen was the modern Platonic Academy, and the scholars and thinkers it produced have been among the greatest in Europe, especially in the 18th and 19th centuries. As with Plato's Academy, where no one could enter who had not mastered geometry, so in Göttingen, it was an unwritten rule that the mastery of the so-called natural sciences and the so-called humanities, was a single process. The mathematician *was* the philologist. This is the only way to explain how the great scholars in theology or mathematics, like Grotefend, turned out to be those who would make fundamental breakthroughs in philology, as in the deciphering of unknown tongues.

Had Göttingen not existed, Grotefend perhaps would not have had the opportunity to develop his extraordinary talents. He did not come from a prominent, wealthy family, but was the son and grandson of shoemakers.[10] His father was proud to have been able to send two of his four sons to Latin school. Grotefend, like Champollion, was fortunate to have an older brother, Johann-Gregor, who took care of his education. His brother became a teacher, in 1789, at the Hannover Paedogogium in Ilfeld am Harz, which made it possible for his younger sibling to attend there in 1792, to prepare for higher studies. Later, on May 3, 1795, Grotefend matriculated at the Department of Theology and Philology at Göttingen University. Since he had no money, he was a non-paying student.

Among his teachers at Göttingen was theologian and amateur Orientalist Thomas Christian Tychsen, the man who,



Göttingen University

Christian Gottlieb Heyne (1729-1812), left, the second leader of Göttingen, was Professor of Classical Philology and director of the University Library. One of his students was the philologist and educator Wilhelm von Humboldt.

in 1802, was to present the first paper announcing Grotefend's decipherment of Old Persian. Another patron/teacher of Grotefend was none other than the great Christian Gottlieb Heyne, the person who led Göttingen for a half-century.

The man who facilitated Grotefend's entry into the faculty at Göttingen, was historian Arnold Hermann Ludwig Heeren (1760-1842), who took on his student Grotefend as a collaborator, and had him teach Latin to the lower- and middle-level classes. Grotefend's commitment to Latin continued throughout his life, as he stayed on later in that capacity at the Göttingen City Gymnasium (classical higher school), and published two Latin grammars. Heeren later included a report by Grotefend on his cuneiform decipherment, in his *Ideen.*

Thanks to Heyne's mediation, Grotefend went to the Frankfurt Gymnasium in 1803, and assumed the posts of prorector, then co-rector. There he taught classical languages and literature, as well as the geography of ancient lands, which had relevance to his philological studies. After a brief deployment at the Lyceum Carolinum, he returned to the Frankfurt Gymnasium in 1814.

Among his colleagues were numerous German thinkers who contributed to historical studies, particularly German. There was, for example, Friedrich Christoph Schlosser (1776-1861) author of the *Weltgeschichte fuer das deutsche Volk* (World History for the German People). Another was the court preacher from Hamburg, Breidenstein, with whom Grotefend in 1817 founded the Frankfuerter Gelehrten-Verein fuer die deutsche Sprache (Frankfurt Scholars Union for the German Language), whose aim it was to "contribute to the education of the mother tongue"—again a brainchild of Leibniz. In 1819, Grotefend was a member of the group which promoted vom Stein's Gesellschaft fuer aeltere deutsche Geschichtskund (Society for Older German Historiography), as well as the *Monumenta Germanaie Historiae.*

In 1820, Grotefend was elected a corresponding member of the Society of Sciences in Göttingen. In 1821, after having taught classical languages and literature according to the Göttingen model in the Frankfurt Gymnasium, Grotefend returned home to Hannover, where he became director of the Hannover Lyceum.

On the occasion of Grotefend's 50th Jubilee, in 1848, which coincided with the 500th Jubilee of his school, he was celebrated with very special honors. He died in 1853. Even a brief overview of Grotefend's life and career shows that he was not some lucky amateur who cracked the cuneiform code, but rather, was a serious scholar and teacher, who had benefitted from the best educational facilities available, forged in the mold of Leibniz.

But, even before he entered the hallowed halls of Göttingen, the young scholar had engaged in a fascinating process of self-education. As he and his biographers emphasize, Grotefend, as a child, was fascinated by problem-solving. Whether with simple puzzles, rebuses, or math problems, the young Grotefend was an impassioned problem-solver, as he himself recalled in his report on his decipherment. Henrich Friedrich Theodor Kohlrausch, who in 1830 was Inspector General of the Learned Schools, provided a wonderfully insightful account of Grotefend's special qualities as a teacher:

> Grotefend's strength lay less in the real grammatical explication, it was more his single flashes of inspiration and peculiar, even from time to time paradoxical thoughts, which he developed with astuteness; he also took here and there a lot of time to refute traditional explanations; through this alone, he awakened the spirit and astuteness of his students, and made them independent. Grotefend was a teacher for good minds, and he educated them further. . . .[11]

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Notes

1. "Jean François Champollion and the True Story of Egypt," by Muriel Mirak Weissbach, *21st Century,* Winter 1999-2000; also in "Sample Articles" at www.21stcenturysciencetech.com.
2. Wilhelm Johann Raphael Fiorillo (1778-1816) was a professor at Göttingen University beginning in 1804. He was the son of a well-known art historian, Johann Dominic Fiorillo.
3. As Niebuhr's son related in a short biographical profile, it was Göttingen Professor Johann David Michaelis who hatched the idea. Prof. Michaelis, who founded historical-critical studies of the Old Testament, went to the Danish Foreign Minister, Freiherrn Johann Hartwig Erast, with the proposal for a trip which would bring back knowledge for the philology of the Old Testament. They required an Oriental philologist as well as a mathematician and a scientific researcher, among others. Abraham Gotthelf Kästner, who had been Professor of Mathematics and Physics at Göttingen since 1756, chose Niebuhr.

   One day in the summer of 1758, Niebuhr's son wrote, Kästner went to his father's room. " 'Would you like to go to Arabia?' he asked. 'Why not, if someone covers the costs,' my father answered. 'The costs,' Kästner answered, 'should be paid by the King of Denmark.' Niebuhr was immediately in agreement, but expressed his doubt whether he were up to such an enormous task. Kästner calmed him down, set a timeframe for prepa-

rations, and advised him especially to study astronomy with Johann Tobias Mayer, the mathematician, physicist, and astronomer."

Niebuhr's son goes on to relate how Niebuhr spent a year and a half in intensive study of math, drawing, history, and the use of mechanical tools. He had private classes in Arabic and astronomy. The trip went from Jan. 4, 1761, to Nov. 20, 1767. The reference is "Das Leben Carsten Niebuhrs, von seinem Sohn geschildert," in Carsten Niebuhr, *Entdeckungen im Orient: Reise nach Arabien und anderen Ländern 1761-1767,* Horst Erdmann Verlag, 1973. ("The Life of Carsten Niebuhr, Presented by his Son," in: Carsten Niebuhr, *Discoveries in the Orient: A Trip to Arabia and Other Lands 1761-1767.*

4. Niebuhr wrote the following about texts B, C, D, in March 1765:

> What is exceptional is that each of them has its own alphabet, and not only here, but also in other locations, one finds the same scripts across from each other on both doorposts. It seems, thus, that the ancient Persians took great care, to immortalize themselves through their inscriptions, just like the ancient Egyptians, who often wrote the same hieroglyphs on all four sides on an obelisk. Both nations have handed their writing strokes down to us. However, not only the Egyptian hieroglyphs, but also these Old Persian alphabets are, unfortunately, now totally unknown! Were the scholars, however, finally able to decipher them, then one must thank the person who commissioned the building, for having had these scripts built in twice. Because they are somewhat damaged on both doorposts, such that the letters that are missing on one side, can be found on the other, and that I was thus able to copy them completely.

Regarding how to read the lines, whether left to right or up to down, Niebuhr wrote:

> In the corners of all the windows are holes, where presumably the hinges of the doors were, so that they could be closed in bad weather. There are such holes also in the corners of the mostly blind windows. All windows and blind windows in this building have old inscriptions at the top and on both sides. Some travellers have wanted to conclude from this, that the ancient Persians, like the Chinese, also wrote from top to bottom. If, however, one considers the inscriptions more carefully, which have been copied by some, and compares them with my copies, one will find that the upright (vertical) rows are all lying on their side. The number of letters is thus by far not so great as one thought from the copies of my predecessors. I have gathered the different letters of an alphabet, which most frequently appear, in table 23, and found not more than 42. . . . [pp. 138-139]

Niebuhr took great pains to reproduce the inscriptions for his readers in such a way that they might think of themselves there, at the monument. Therefore, he always gave measurements of the buildings, stones, and so on, to make sure scholars would grasp the reality. For example, Niebuhr wrote:

> But I hope that a future European traveller there would like to copy even more from the ancient writings located in said place, and in such a way, that one may distinguish each letter in the drawing, as in the original. This did not happen with Kaempfer, Chardin, or le Bruyn, and I suspect that this is the reason why no scholar has yet come to explain them. I want to add to Table XXXI one, or, many more, four inscriptions H, I, K, L, which I found all side by side each other, about in the middle of the main wall looking south. The stone they are on is 25 feet long, and 6 feet high, and is completely covered with them. One can thus judge the size of the letters. Here, too, are three different alphabets.

5. Herodotus. *Herodotus, A New and Literal Version, From the Text of Baehr, with a Geographical and General Index,* translated by Henry Cary, (London: 1879), "Xerxes the son of Darius": vi, 98; vii, 1-20, 26, and so on.
6. *Herodotus, ibid.,* "Darius son of Hystaspes, who was son of Arsames (not a king)":I, 209, iii. 70, vii, 224.
7. See Ernst Doblhofer, 2000. *The Decipherment of Old Scripts and Languages* (Stuttgart: Philipp Reclam).
8. G.W. Leibniz, "Foundations of a Memorandum on the Establishment of a Society for the Promotion of Arts and Sciences in Germany," 1671, in *G.W. Leibniz, Collected Writings and Letters,* published by the Prussian Acadmey of Sciences, Berlin. *Political Writings,* Vol. 1, appeared in 1931, p. 530 ff. Also reproduced in the German edition of *The Science of Christian Economy* by Lyndon LaRouche (Wiesbaden, Germany: Boettiger Verlag, 1992).
9. Götz von Sele, *Universität Göttingen—Wesen und Geschichte (*Göttingen University—Nature and History), (Göttingen University, 1953).
10. Grotefend was not the only genius who came from a family of shoemakers. Lyndon LaRouche is a modern example. See Lyndon LaRouche, *The Power of Reason,* (Washington, D.C.: Executive Intelligence Review, 1988).
11. "Georg Friedrich Grotefend: A Biographical Sketch," by Karl Brethauer and Waldemar R. Roebein, in *The World of the Ancient Orient: Cuneiform, Excavations, Scholars* (Göttingen, 1975), p. 12.

Bibliography

Dr. R. Borger, Dr. W.R. Roehrbein, Dr. Wolfgang Schramm, 1975. "Grotefend und die fruehe Keilschriftforschung" (Grotefend and the Early Cuneiform Research), in *The World of the Ancient Orient: Cuneiform, Excavations, Scholars,* Handbook and Catalog of the Exhibition, in Honor of the 200th Birthday of Georg Friedrich Grotefend, June 9, 1775-Dec. 15, 1835 (Göttingen).

Ernst Doblhofer, 2000. *Die Entzifferung alter Schriften und Sprachen* (The Decipherment of Old Scripts and Languages), (Leipzig: Reclam Verlag).

Johannes Friedrich, 1957. *Extinct Languages* (New York: The Philosophical Library).

Georg Friedrich Grotefend, (1983). "Praevia de Cuneatis, quas vocant, Inscriptionisbuc Persepolitanis Legendis et Explicandis Relatio," Unveraenderte reprographischer Nachdruck aus: *Nachrichten der Koeniglichen Gesellschaft der Wissenschaften und der Georg-Augustus-Universitaet zu Goettingen,* Unaltered Reprographic Copy from *News of the Royal Society of Sciences and the Georg Augustus University at Göttingen,* Vol. 14, pp. 571-676.

Georg Friedrich Grotefend, (1972). "G. Fr. Grotefends erste Nachrichte von seiner Entzifferung der Keilschrift" (G. Fr. Grotefend's First Notice of his Decipherment of Cuneiform), printed by W. Meyer (Darmstadt: Scientific Book Society).

Georg Friedrich Grotefend, (1975). "Grotefends erste 'Praevia.' Einfuehrung, Faksimile, Uebersetzung, Kommentar." Professor Dr. Rykle Borger, in *Die Welt des Alten Orients: Keilschrift, Grabungen, Gelehrte* (Grotefend's First 'Praevia.' Introduction, Facsimile, Translation, Commentary) in *The World of the Ancient Orient: Cuneiform, Excavations, Scholars,* Handbook and Catalog of the Exhibition, in Honor of the 200th Birthday of Georg Friedrich Grotefend, June 9, 1775-Dec. 15, 1835 (Göttingen).

A.H.L. Heeren, 1793, 1805, 1817. *Ideen ueber die Politik, den Verkehr und den Handel der vornehmsten Voelker der alten Welt* (Ideas on the Politics, Travel, and Trade of the Most Distinguished Peoples of the Ancient World), (Göttingen).

Herodotus, 1879. *A New and Literal Version, From the Text of Bahr, with a Geographical and General Index,* translated by Henry Cary, M.A., *(Worcester College, Oxford, London: George Bell & Sons).*

Prof. Dr. Walter Hinz, 1975. "Grotefends genialer Entzifferungsversuch" (Grotefend's Genial Attempt at Decipherment), *in The World of the Ancient Orient: Cuneiform, Excavations, Scholars,* Handbook and Catalog of the Exhibition, in Honor of the 200th Birthday of Georg Friedrich Grotefend, June 9, 1775-Dec. 15, 1835 (Göttingen).

Kurt Huber, 1989. *Leibniz: Der Philosoph der universelen Harmonie* (Leibniz, Philosopher of Universal Harmony), (Munich: Piper).

Gottfried Wilhelm Leibniz, (1931)."Grundriss einer Denkschrift ueber die Einrichtung einer Societaet zur Feordereung der Kuenste und Wissenschaften in Deutschland," in *Saemtliche Schriften und Briefe* (Foundations of a Memorandum on the Establishment of a Society for the Promotion of Arts and Sciences in Germany), in *Political Writings* (Berlin: Prussian Academy of Sciences), p. 530 ff.

Carsten Niebuhr, (1972). *Reisebeschreibung nach Arabien und andern umliegenden Laendern 1774-1837* (Descriptions of Travel to Arabia and other Surrounding Lands 1774-1837); new, abridged edition (Zurich: Manesse Library of World History).

Carsten Niebuhr, (1973). *Entdeckungen im Orient: Reise nach Arabien und anderen Laender, 1761-1767* (The Life of Carsten Niebuhr, Presented by his Son) in Carsten Niebuhr, *Discoveries in the Orient: A Trip to Arabia and other Lands 1761-1767*), (Horst Erdmann Verlag).

Walter Nissen, 1972. *Goettingen gestern und heute,* (Göttingen Yesterday and Today), (Göttingen).

Dr. Waldemar R. Roehbein, 1975. "Biographie Georg Friedrich Grotefends," (On the Biography of Georg Friedrich Grotefend), in *The World of the Ancient Orient: Cuneiform, Excavations, Scholars,* Handbook and Catalog of the Exhibition, in Honor of the 200th Birthday of Georg Friedrich Grotefend, June 9, 1775-Dec. 15, 1835 (Göttingen).

Rudolf Smend, 1951. *Die Goettinger Gesellschaft der Wissenschaften, Festschrift zur Feier des 200 Bestehens der Akademie der Wissenschaften in Göttingen* (The Göttingen Society of Sciences, Festschrift to Celebrate the 200th Anniversity of the Existence of the Academy of Sciences in Göttingen (Berlin, Göttingen, Heidelberg: Springer-Verlag).

Gotz von Sele, 1953. *Universitaet Göttingen—Wesen und Geschichte* (Göttingen University—Nature and History), (Göttingen).

How Radiation Saves Lives

by James Muckerheide

There has never been a time that the beneficial effects of low-dose radiation were not known.

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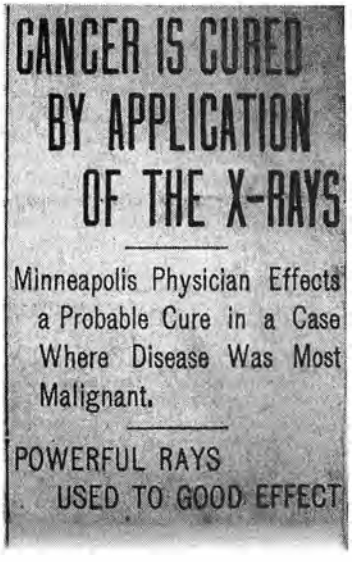
Left: An 1897 photo of an X-ray treatment for surface lesions, which had early positive results. Note that the eyes are shielded. Below: A typical headline on the benefits of X-rays, from the early 20th Century.



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In 1896, within a few months after Roentgen published his groundbreaking paper on the discovery of X-rays, the health benefits of low-dose X-rays were demonstrated, along with many reports of high-dose harm. We now know that the response described was primarily immune-system stimulation. It cured and prevented diseases, especially infections and inflammations.

There were many successful applications of these low-dose effects. Careful medical work showed that "more dose" did not help, when such applications did not work. But, to many people, "more is better," and excessive doses were given, some of which produced delayed effects (for example, cancers). But, ignoring the data about dose and response, it was claimed that "radiation use produces cancer" in such applications, and many successful applications were terminated as accepted medical practice. They were often replaced with less effective, but more profitable, drugs.

In 1932, Eben Byers died from ingesting radium. At age 51, he had found that it stimulated his health and well-being. But he ingested it at millions of times more than low doses, and it produced bone necrosis, gruesome disfigurement, and death after three years. *Time* magazine ran a full-page obituary, with pictures. The Food and Drug Administration (FDA) then obtained authority over radiation and, without studying the health effects in thousands of radium users and workers, the FDA limited radium and radiation use to the medical/pharmaceutical industry.

In 1936, a National Academy of Sciences study supported the Food and Drug Administration, discounting the known stimulatory effects of low-dose radiation on the immune system. This approach continued after World War II: Data and research showing that low dose radiation is not, and cannot be, harmful—and can even be beneficial—were simply ignored by Federal agencies and their "advisory bodies." The various rationales for such bias were the desire to foster fear of nuclear weapons, to support the medical and pharmaceutical industries, and to gain support for radiation-protection funding and programs.

The Discovery of X-rays and Benefits

The following news item was reported in *The Electrical Engineer,* Aug. 19, 1896, under the headline "Experiments with X-Rays Upon Germs":[1]

> Some experiments have been made by Dr. William Shrader, of the Missouri State University, to test the effect of the Roentgen rays upon various disease germs. In nearly every instance these are reported to have met with success and prove conclusively that the rays are

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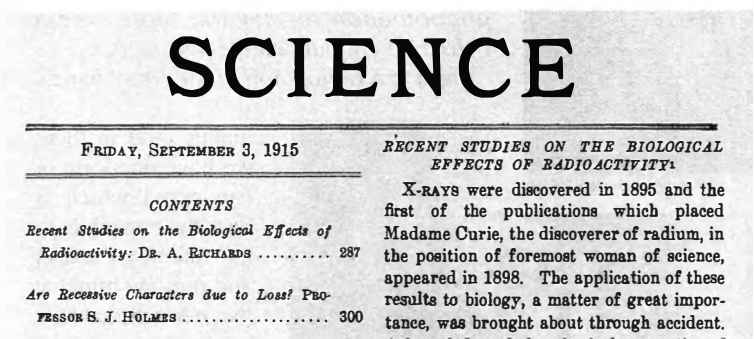
People seeking relief from a variety of ailments by renting seats in a radon mine shaft, to soak up the low-dose radiation.



SCIENCE

FRIDAY, SEPTEMBER 3, 1915

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RECENT STUDIES ON THE BIOLOGICAL EFFECTS OF RADIOACTIVITY[1]

X-RAYS were discovered in 1895 and the first of the publications which placed Madame Curie, the discoverer of radium, in the position of foremost woman of science, appeared in 1898. The application of these results to biology, a matter of great importance, was brought about through accident.

The cover story of Science *magazine, Sept. 3, 1915, featuring Dr. A. Richards's article "Recent Studies on the Biological Effects of Radioactivity."*

invaluable in the treatment of these diseases. Among the first experiments were those made with the diphtheria bacilli; tubes were inoculated with the germs, one exposed to the rays and the other not exposed. In the former, the germs were destroyed, while in the latter they lived.

Following these tests, two guinea pigs were inoculated with a solid culture of diphtheria, prepared in the bacteriological laboratory of the university. These pigs weighed 210 and 185 grams respectively. One was exposed to the rays for four hours in a wooden box, having a rubber cover, and is alive today after eight weeks, and no trace of the disease can be found. The other pig, not exposed to the rays, died within 28 hours after the injection of the poison. The post-mortem examination showed that his death was due to the diphtheria germs.

These effects were repeatedly confirmed over many years. They led to successful applications of low-dose radiation in stimulating the body to reject infections and inflammatory diseases. In the same issue of *The Electrical Engineer,* there is a report of the Rede lecture at Cambridge University, in which Prof. J.J. Thomson states about X-rays: "Unfortunately, they do not exert any of those deleterious effects on bacteria which are fortunately associated with ultraviolet light." Thomson also states that the energy is small. He finds no effects that "involve the expenditure of an amount of energy produced by a candle in one second"; and "no appreciable effect on the combination of hydrogen and chlorine, though this is a good test of the intensity of very faint light."

The editorial section of the same issue reported on the "Physiological Effects of X-rays":[2]

From the evidence of various experimenters, it is apparent that considerable more investigation will be required to determine what the physiological effects of X-rays are, or even whether any such effects are produced by them at all. The testimony on this subject is very conflicting, even taking only that of the highest authorities. Prof. J.J. Thomson, in the Rede lecture at the University of Cambridge, states that X-rays do not exert any of those deleterious effects on bacteria which are fortunately associated with ultraviolet light. In contradiction to this statement we print elsewhere a note concerning some experiments made by Dr. William Shrader, of the Missouri State University, on the effect of Roentgen rays on disease germs. In nearly every instance the germs were found to be destroyed by the action of the rays. The experiments with diphtheria bacilli appear to be conclusive, and from other sources we have heard of a number of equally successful experiments in treating consumptive patients with X-rays, but in the face of such contradictory evidence it is necessary to suspend judgment for a time, until more data on the subject is brought to light.

In respect to one effect of these rays the evidence is pretty well united. Nearly all those people who have worked extensively in this field state that wherever the rays pass through the flesh the latter becomes apparently sunburned and the hair falls off the exposed surface. This whole subject opens up a field of the utmost interest and one from which highly important results from a medical standpoint may occur.

We deeply regret to note here the death of Dr. Shrader, whose investigations are referred to above . . . ."

Further confirmation and perspective was reported in the December 1896 *Electrical World,* with a report on the Nov. 28 *La Nature,* magazine, published in France:[3]

"Effect of X-rays on the Skin." C.E.G. *La Nature,* Nov. 28. After giving an account of the experiences of an X-ray demonstrator at a recent exhibition, he suggests that the cause might be due to the decomposing action of the X-rays on the gases which they traverse; if the action is the same on the liquids of our organism, acid or alkaline substances should be set free, the quantity of which would be very small, but their effect should be to completely disorganize the tissues; he thinks it may be due to this phenomenon that the different actions of the X-rays, if on bacilli, may be attributed; if the rays act after inoculation it surrounds the bacilli with a medium which destroys or dilutes them, but in cultures these destructive media are not produced, and there is therefore no action; this might explain why some observers have found such actions, while others have obtained negative results.

The Biological Effects of Radium

by Wm. Allen Pusey (1911)

This address was presented before the Illinois State Academy of Sciences, Chicago, Feb. 18, 1911, and published in Science *magazine, June 30, 1911. These are excerpts from the 1911 publication in* Science*; some punctuation has been added.*

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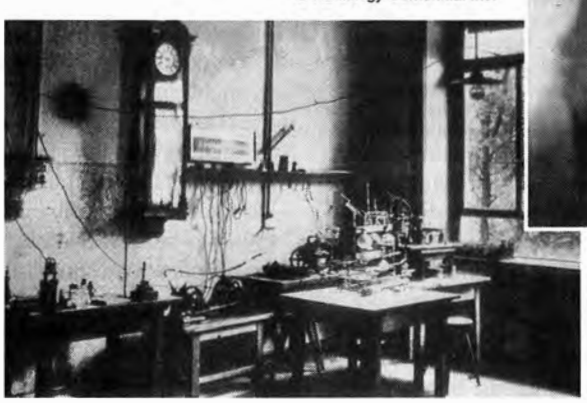
William Conrad Roentgen (1845-1923) in 1896. Roentgen was working in this laboratory at the Physical Institute of the University of Wurzburg on emissions generated by discharging electrical current in evacuated gas tubes. On Nov. 8, 1895, he noticed that one of his charged tubes, which was covered with cardboard, caused a screen across the room to glow. He experimented with the phenomenon for several more weeks before he announced the discovery.

Inset is a radiograph of his wife's hand.



Among the first discoveries made after the production of concentrated radium salts was that radium is capable of causing intense effects upon living tissues. We were not unprepared for such a discovery in the case of radium, because similar phenomena had been observed early in the study of X-rays.

(We have here, as a result of these powerful forms of radiant energy, a picture of extreme interest. The condition is in fact an exact, sometimes an exaggerated, picture of the atrophic senile skin, with its dilated blood vessels and senile keratoses. As a matter of fact the picture is so nearly that of senile skin that I was able, in the case of X-ray lesions, to predict that cancers of the skin would be found to develop in them because the keratose of old age are so frequently the starting point of cancers . . . the identity of chronic X-ray and radium changes in the skin with those of the senile skin, strongly indicate that the senile changes of the skin are in good part the result of the less powerful action over a long period of years of sunlight. . . .

Cancers develop in the keratoses of X-ray and radium dermatitis, and in them we have one form of carcinoma which is directly traceable to its exciting cause; and only by bringing in a *deus ex machina* in the form of later infection can one avoid the conclusions that at least in these lesions we have cancer which is not of microbial origin.)

The microscopic changes in tissues undergoing a radium reaction are even more interesting than the gross changes. In the early stages of radium irritation, sections show evidences of proliferation of the tissue elements, such as indicate an overstimulation of the cells by a particular irritant. These changes are most marked in the tissues of the greatest functional activity. At first there are an increased production of pigment, and an exaggerated proliferation of the germinal and younger (deeper) cells of the epidermis, especially of the cells of the follicles of the epidermis. . . .

This, of course, is the biological response to infections: stimulating the immune system to attack bacteria, in which macrophages engulf the "foreign bodies" of the bacteria.

Another 1896 report was not printed until Jan. 9, 1897, in *Electrical World,* because the editors waited two months to evaluate the credibility of the authors and their report. In this article, Caffrey and Wilson "reported on their experience with low-dose X-rays, both with their own injuries and the treatment of patients.[4] This article is reprinted on page 78.

The 'Next Phase' of Low-Dose Response Research

Despite these early indications of the positive effects of low-dose radiation, and similar reports in the biology and medicine literature, there was limited use of the evidence. The medical community had little "scientific ethic," and there was little correspondence between biologists and medical people. Also, the attention given to the rapid "improvement" of X-ray instruments, to produce much higher dose rates and doses, succeeded in making it easy for researchers to "skip over" the doses at which beneficial effects had been produced, somewhat by accident, at low doses. This was combined with primary medical interests in both the high-dose/dose-rate applications for therapeutic imaging and for cancer tumor therapies.

There was much more research with low-dose response in botany. A substantial summary of the initial research was reported in 1908 by Gager.[5]

A more comprehensive review of botanical and physiological studies, is a 1915 *Science* cover story by A. Richards[6] in which he summarized current knowledge, but with more attention to high-dose responses than low doses. However, the clear knowledge and understanding of opposite effects at low dose were noted.

For example, Dr. Richards states:

> In general, it may be said that when living cells are exposed to action of radioactivity, the vital functions are retarded or depressed and a permanent injury may result; this depends on three factors, the strength of the radiating substance, the duration of the exposure, and the distance of the object from the source of the radiation, When the intensity of the radiation is great, owing to exposure at short range to a strong preparation (or strong current in the case of X-rays) for a long time, the effects are much more injurious than when the intensity is less. Indeed, numerous cases have been reported where a qualitative difference results from a slight radiation as contrasted with one of great intensity, for frequently stimuli which will retard growth if of high degree will be found to accelerate it if weak enough.

Richards also makes the following statement:

> In rapidly growing tissue, such exposure will cause a decrease in the rate of division as well as interfering with its regularity. On the other hand, an exposure of short duration and of slight intensity will in some cases stimulate growth, and accelerate regeneration, and may perhaps cause an increase in the rate of cell division.

Specifically on plant response, Richards confirms Gager:

> Gager reviews the literature on this subject up to 1908 and summarizes the state of knowledge at that time in his last paragraph as follows:
>
> "The broadest, and at the same time the most definite generalization warranted by the work so far done is that the rays of radium act as a stimulus to metabolism. If this stimulus ranges between minimum and optimum points, all metabolic activities, whether constructive or destructive, are accelerated, but if the stimulus increases from the optimum toward the maximum point it becomes an overstimulus, and all metabolic activities are depressed and

> It is evident in this process that we are dealing with an agent whose results are produced by influencing the biological processes of the cells themselves. The effects are not produced by an immediate destructive action of the rays, as a heat burn, for example, is produced. There is no immediate effect from the application of radium; it is only after days, it may be two or three weeks, that the effects appear. The inference is that the radiations set up some process in the tissues which itself ends in their destruction. The whole process is one of exaggerated stimulation of the activity of the cells of the tissues: a stimulation which varies in degrees with the degree of specialization or functional activity of the different types of cells. In its slightest degrees it is the ordinary protective process that occurs under exposure to sunlight, but under the unusual and extreme irritation of this artificial form of radiant energy the reaction becomes destructive.
>
> Thus there is produced by radium: (1) A stimulation of the cells. . . .
>
> These effects upon tissues suggest various therapeutic purposes: (1) To stimulate chronic processes. This principle has been successfully used in the treatment of some chronic inflammatory processes in the skin. . . .
>
> Several experiments have shown the inhibitive or, under stronger exposures, the destructive, effect of radium rays upon various bacteria in cultures. . . . These are the only biological findings differing from those with X-rays, and are probably due to the greater superficial effect of the alpha and beta rays, because of their very slight penetration as compared with the softest X-rays. They indicate a close similarity, with a difference chiefly in degree, in their biological effects between alpha and soft beta rays and ultraviolet rays.
>
> Similar results have been obtained by several observers from exposures of numerous forms of protozoa. Their growth is at first stimulated, then inhibited, and after intense exposures, they are destroyed.
>
> In plants, the results of experiments may be summarized briefly as first stimulation of growth, and under stronger applications, retardation or complete inhibition of growth.
>
> This consideration has been directed to the effects of radium rays. As to the emanations [radon!—J.M.], it may be stated briefly that experiments with the emanations with young mice, upon bacteria, and upon protozoa show results quite like those from exposure to the rays.

finally completely inhibited. Beyond a certain point of over-stimulus recovery is impossible, and death results."

"Cells contain a great many kinds of enzymes and it has been shown by a number of investigators that radium rays and X-rays have the property of modifying the action of some enzymes. Packard concludes that while many enzymes may be activated, 'the lytic enzymes are more stimulated than those which play a synthesizing role.' Where a slight radiation results in acceleration, the synthetic processes may be supposed to be stimulated more than the destructive activities."

Richards reports on then-current research, much in Germany, and competing theories of the biological actions of the X-rays. His own results attempt to explain the mechanisms behind the clear evidence of biological responses. These actual responses have been ignored by review bodies for the last 60-plus years, denying the evidence (to "explain" why such results do not exist), instead of trying to explain the plain, repeated, and consistent, results.

Richards writes:

> It has been found by numerous investigators that radium rays have the power to affect enzymes, and the writer[15] has shown that X-rays are able to bring about modification in the activity of certain enzymes. Enzymes are derived from living tissues and if it is possible to cause their modification outside of the cell by the use of radioactivity it is not improbable that they also undergo change while with-

Medicinal Properties of Roentgen Rays

by William G. Caffrey and Nathaniel Wilson (1897)

This article appeared in The Electrical World, *Jan. 9, 1897. Some punctuation has been added.*

To the Editor of *The Electrical World:*

SIR: —Thinking that some of the results we have obtained with Roentgen rays may be of interest, we submit the following.

In exhibiting at the State Fair Pavilion in September, Prof. Wilson had the fingers of his left hand in front of a fluoroscope continuously for three hours each evening for two evenings in succession. No noticeable sensation was felt at the time, but in about one week, a severe burning sensation was felt in the bones, especially at the joints. The fingers swelled, the joints turned black and an intense inflammation set in, accompanied by excessive pain. By treating them as an ordinary burn, immense blisters developed, extending from the nails to the knuckle and covering half the finger in circuit. They then sloughed, and by using dry boracic acid, he eventually healed them up.

Again, about the 10th of September, Mr. Caffrey mashed his left thumb with a hammer, and, as is the case with such bruises, it pained him excessively. Thinking that possibly the bone had been broken, we made a radiograph of it. Not having any small plates on hand, and having some gelatin films 14 years old, we used one of them, and exposed the thumb 30 minutes to the rays in order to be sure of an image on the old film. At the end of that time, he was surprised to find that the pain had disappeared, and up to today there has been no pain at all in the thumb.

Wishing to investigate this subject further, we persuaded a bookkeeper to try the treatment. He was suffering from rheumatism to such an extent that a grain of morphine each night was necessary to enable him to sleep, and for five nights he had not had his clothes off. We exposed the affected hand for one half hour to the rays and that night he slept splendidly, the pain having almost entirely ceased. The next night we again treated him for 30 minutes and the following day he went to work. In a few days the swelling ceased entirely, and since then he has had no return of the rheumatism.

The next case was a lady about 50 years old, who had lost the use of the fingers on her left hand, due to rheumatism, the disease being of five months standing. We treated her in precisely the same manner, and she immediately recovered the use of her fingers.

The next case was a young lady suffering intensely with rheumatism in her elbow. After two treatments, she could use her arm. This case was one of inflammatory rheumatism that had existed about one month and the doctor had given it up. In three days the swelling disappeared and the use of the arm was regained. The next person to be treated was the wife of a prominent local physician, who had had rheumatism, centering in the hand, since July last. After a treatment of 30 minutes she could use her hand and has done so ever since. In all these cases except the first we noticed evidences of slight sunburn, but nothing serious resulted therefrom.

The next case was a woman about 50 years of age, weighing over 300 pounds, who had injured her knee in getting into a buggy. She had been in bed continuously for nine weeks. We undertook to make a radiograph of the knee. Owing to the immense size of the limb we were at a loss to know the exact time for exposure, but gave the plate an exposure of two hours. This we found to be an over exposure. At the end of this time, the lady got up and walked around without assistance, finally walking down a flight of 15 steps to her buggy. Since then (five weeks now) she has had the use of her limb without pain, and apparently is as well as she was before the injury. Her physician was in attendance during the treatment and was nonplussed at the result.

The next case was one of bronchitis of 30 years standing. We are still treating this gentleman, and the results so far have been remarkable. For 25 years he had not slept the entire night without waking up almost choked. But after the second treatment he was enabled to sleep all night, and now the pain has ceased entirely, the cough has been reduced over one half, the expectoration is not nearly what

in the cells. In fact, the writer working with Miss Woodward . . . was able to prove that X-rays can be used to influence the activity of the cell extractive called fertilizin. . . . Its behavior is in some respects comparable to that of an enzyme and it is possible that the substance contains enzymotic bodies. The experiments showed that radiation by X-rays is capable of changing the activity of fertilizin, and in general agrees with previous work that weak radiation is accelerative and strong inhibitive.[7,8]

In his conclusions, Richards again refers to Gager:

> From Gager's conclusions that radioactivity is a stimulus to metabolic processes, it may be inferred that the functions, as cell division, which even remotely depend on these processes, would also be affected by radiation. Such an inference is borne out by the observations . . . made by the writer on the rate of division in *Planorbis* eggs that had been exposed to X-rays, for in these experiments it was found that a light radiation served to accelerate the first one or two mitotic cycles that followed it; after that injurious effects gradually asserted themselves. A strong radiation was directly inhibitive."[9]

Finally, on low versus high doses, Richards states:

> The facts, as they are at present known in regard to the effects of radioactivity on living matter, show that life

it was, and it is quite apparent that the treatment has killed the germs of fermentation, as the expectorated matter has no taste or odor. He can now use his voice immediately upon arising where, heretofore, it was several hours before he could speak above a whisper. His entire demeanor has changed, and he claims to his friends that he is being cured.

The next case, and one which we consider the most remarkable, is a physician who came to this town on account of the climate and altitude. He has been suffering for about four years with tubercular consumption, and has used nearly every known remedy. He wanted to try the Roentgen rays, and before treating him we had him send some of his sputum to Cooper Medical College in San Francisco for examination, with the result that a large number of bacillae tuberculosis were reported present. We then treated him for five days in succession, using an eight-inch tube, the time of treatment varying from three-quarters of an hour to an hour. He again sent his sputum for examination, and the following is the answer from Cooper College: "We find bacillae still present, but they have decreased both in size and number. We congratulate you upon your improvement."

After the first treatment he noticed a remarkable change in his general health, and since then he has lost that pallor which is so characteristic in this disease. He has also noticed the absence of fermentation germs since using this treatment, also a marked decrease in the cough and amount of sputum. We are still treating him. In neither of these cases have we been able to detect any indication of sunburn.

The next case was little girl brought to Reno from Washoe City, to have a hand amputated. A sore had developed on the back of her hand at the knuckle joint of the third finger, and was continually giving off pus. We made a radiograph of the hand and discovered three pieces of glass lying next to the joint. Owing to the cramped condition of the fingers we were obliged to make a second negative, using a film in the place of a glass plate. Immediately after this treatment she sat upon her father's knee and fell asleep in his arms, not having been able to sleep before for several days. At the end of two weeks, her father returned and brought a piece of bone which had sloughed out and reported that the inflammation had entirely disappeared and that the sore had healed over. From the time of the making of the radiograph to the present time she has had no pain.

An X-ray treatment for surface lesions in the late 1800s.

William C. Caffrey, Nathaniel E. Wilson, Reno, Nev.

[The above communication was received some two months ago, but for obvious reasons was not published. Personal inquiry has, however, led us to believe that Messrs. Wilson and Caffrey are perfectly sincere in their statements. Messrs. Wilson and Caffrey's experiments show that either Roentgen rays or some other phenomenon accompanying them has an exceedingly powerful action, or the subjects upon whom they experimented have been materially benefited due to an equally powerful mental belief in their efficacy. The above letter is published not for the purpose of creating the hope that Roentgen rays are capable of alleviating human suffering, but with the possibility that some wheat may be sifted from the chaff with which it is considerably imbued.—Ed.]

processes are subject to marked changes under the influence of the radiation, a slight exposure being accelerative in most cases while a more intense treatment is inhibitive or destructive.

The Early 20th Century

Hundreds of studies and reports of successful medical applications of low-dose radiation, especially for dramatic benefits in infections and inflammatory diseases, were reported from the turn of the century, to much more formal research and reports up to the 1940s, and beyond.

One dramatic effect is the immediate termination of gas gangrene. Where even amputations had largely failed, with 80 percent mortality rates, irradiation before, and well into gangrene progression, halted the progress of gangrene. After the disease was halted, damaged tissue was clearly demarcated and could be removed, not as with amputation, an attempt to "get ahead" of its progress, or the early general failures of the serum and sulfanilamide drugs (except very early in the disease). J.F. Kelly wrote several reports. See especially his 1941 paper and 1942 book with D.A. Dowell.[10]

In the 1910s and 1920s, early work on immunity and cancer showed that low-dose radiation reduced cancer incidence in animal experiments. For example, J.B. Murphy, in a report as part of a series of investigations on cancer immunity, on the effect of physical agents, specially radiation and heat, in the *Proceedings of the National Academy of Sciences* in 1920, found increasing multiple small radiation doses would destroy lymphocytes, leading to increases in cancer:[11]

> In the course of this investigation of the action of X-rays, it was noted that, while repeated small, or a single large, dose would destroy the (lymphocytes), a single small exposure to a ray of suitable quality would stimulate the lymphocytes. The stimulation was judged by the numbers of circulating lymphocytes and the state of activity of the germinal centers in the spleen and lymph nodes as indicated by the number of mitotic figures present. This method of increasing the lymphoid elements of the body was first used in an attempt to increase the resistance of mice to replants of their own spontaneous tumors. By this treatment we increased the resistance from 3.4% in our control series to 50% in the treated series.
>
> By a similar induced lymphocytosis, we have been able to develop a resistance to transplanted cancers. . . . The procedure here was to expose a number of mice to a stimulating dose of X-rays and then inoculate them with a transplantable cancer a week later, at the same time inoculating a series of controls. The following table gives the result of these experiments:

Experiment Number	I	II	III	Average
Takes in X-rayed mice	25.0%	29.0%	28.6%	27.5%
Takes in control mice	77.8%	87.5%	60.0%	75.1%[12]

These results have been frequently repeated over the last 85-plus years.

Also during the early part of the century, evidence of longer life, better health, wound healing, and improved fertility, along with reduced cancer and other chronic and fatal diseases, were reported. It was found that many "health spas," long known for beneficial health effects (some for hundreds to thousands of years), were radioactive.

There was renewed interest in their use, and even to transport radioactive materials to people, overcoming limited access to these facilities; for example, there was bottled water labeled "radioactive." Radium extraction made both radium and its radon gas product available in local facilities for medical use. Today, hundreds of such facilities have been developed around the world; many are now closed, but some new ones are opening. Medical insurance provides such treatments in some countries. However, research on the mechanisms of such exposure is severely limited by the research establishment that is primarily funded by government "radiation protection" agencies.

Current Reviews

The most comprehensive current review of the biological responses to radiation health effects at low doses have been conducted by Dr. T.D. (Don) Luckey, Prof. Emeritus of the University of Missouri-Columbia School of Medicine. His two monographs on the subject[12] incorporated virtually all of the significant literature in the various relevant fields of biology.

Unfortunately, this does not include all of the work done in radiobiology and toxicology, which have a limited connection with biology. These fields drifted into mechanistic studies with little substantial contribution to, or assessment of, the biology literature, especially in the last 40 years in which the influences of physics have led to largely irrelevant but large, costly, experiments. Dr. Luckey continues to contribute to assessing the data; new papers and the data being developed are reported by Radiation, Science, and Health in a "Data Document," available on its web site: http://cnts.wpi.edu/rsh/.

Characteristically, in studies with appropriate dose ranges and research on relevant factors, the results are not considered by the responsible institutions (government, industry, and research).

Another substantial effort to examine the issues and the literature is led by Dr. Edward Calabrese at the University of Massachusetts at Amherst, and the science group, Biological Effects of Low Level Exposure (BELLE), formed in 1990. This group addresses both low-dose chemical and radiation exposures. However, it is primarily oriented to toxicology on the significance of "bi-phasic effects" at low doses, and the potential policy implications to toxicology if the effect were to be acknowledged by the regulatory agencies.

BELLE's web site, http://www.belleonline.com, includes its newsletter. A series of papers by Dr. Calabrese and Linda Baldwin examines the historical foundations of the science, the demise of the hypothesis, and the "marginalization" of the science.[13] It is clear that this marginalization was not an "accident."

Suppression of Evidence

The suppression of the evidence of the beneficial health effects of low-dose radiation started in the 1930s, led by medical and pharmaceutical interests, and later by the "radiation

protection" bureaucracies.

Contemporary reports from around 1896 show that low radiation doses stimulate an immune response to prevent deaths by infections. Many later studies confirm that such effects prevent and treat cancers and infectious and inflammatory disease, and improve health and increase mean lifespan. These data are not considered by radiation protection interests—generating hundreds of billions of dollars extracted from public funds. It will be necessary to challenge federal agencies that falsify science data in making rules, and allege science misconduct by some scientists. Substantial petitions for rulemaking, and requests to approve medical applications, can be submitted to the responsible agencies to effect change in medicine and radiation protection. Without concerted effort, not limited to science, the relevant science will continue to be suppressed and falsified.

Jim Muckerheide, the State Nuclear Engineer for the Commonwealth of Massachusetts, is a founder and President of Radiation, Science, & Health, which is committed to establishing a radiation policy based on science. He is also co-director of the Center for Nuclear Technology and Society at Worcester Polytechnic Institute in Massachusetts, which is working to establish a "level playing field" for decisions on the costs and benefits of nuclear technologies that are essential to human prosperity in the 21st Century. His previous article, "It's Time to Tell the Truth about the Health Benefits of Low-dose Radiation," appeared in the Summer 2000 issue of 21st Century, *and can be accessed on the* 21st Century *website, http://www.21stcenturysciencetech.com.*

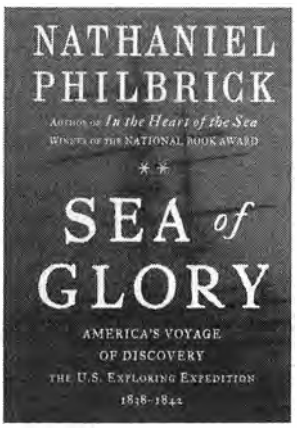
References

1. "Experiments with X-rays upon Germs," 1896. *The Electrical Engineer,* Aug. 19, Vol. XXII. No. 433, pp. 176-7.
2. "Physiological Effects of X-rays," 1896. *The Electrical Engineer,* Aug. 19, Vol. XXII. No. 433, p. 183.
3. "Effect of X-rays on the Skin," 1896. Abstract, La Nature, Nov. 28, in *Electrical World,* December.
4. W.G. Caffrey and N.E. Wilson, 1897. "Medicinal Properties of Roentgen Rays," *Electrical World,* Jan. 9, p. 67.
5. C.S. Gager, 1908. "Effects of the Rays of Radium on Plants," *Mem. N.Y. Bot. Garden,* IV, and "Some Physiological Effects of Radium Rays," 1908. *The American Naturalist,* Vol. 42, No. 504, December, pp. 761-78.
6. A. Richards, 1915. "Recent Studies on the Biological Effects of Radioactivity," *Science,* Sept. 3, Vol. XLII, No. 1079, pp. 287-300.
7. A. Richards, 1914. "The Effect of X-rays on the Action of Certain Enzymes," *Amer. Jour. Physiol.,* Vol. 35.
8. A. Richards and A.E. Woodward, 1915. "Note on the Effect of Xradiation on Fertilizin," *Biol. Bull.,* Vol. 28.
9. A. Richards, 1914. "The Effect of X-rays on the Rate of Cell Division in the Early Cleavage of Planorbis," *Biol. Bull.,* Vol. 27.
10. J.F. Kelly, D.A. Dowell, 1941. "Twelve-Year Review of X-ray Therapy of Gas Gangrene," *Radiology,* Vol. 37, pp. 421-39; *Roentgen Treatment of Infections,* 1942. (Chicago, Ill.: The Year Book Publishers). http://cnts.wpi.edu/RSH/Docs/Kelly42/Kelly42TableOfContents.htm.
11. J.B. Murphy, 1920. "The Effect of Physical Agents on the Resistance of Mice to Cancer," *Proc. of Nat. Acad. Sci.,* Vol. 6, pp. 35-38.
12. T.D. Luckey, 1980. *Hormesis with Ionizing Radiation* (Boca Raton, Fla.: CRC Press) and *Radiation Hormesis,* 1991 (Boca Raton, Fla.: CRC Press).
13. E.J. Calabrese and L.A. Baldwin, 2000. "Radiation Hormesis: Its Historical Foundations As a Biological Hypothesis," *Hum. Exp. Toxicol.,* January ,Vol. 19, No. 1, pp. 41-75. "Radiation Hormesis: The Demise of a Legitimate Hypothesis," pp. 76-84. "The Marginalization of Hormesis," pp. 32-40.

The Case of the Purloined Pole

by Rick Sanders

The Sea of Glory
by Nathaniel Philbrick
New York: Viking, 2003
Hardcover, 452 pp., $27.95



This is not a book review of *Sea of Glory,* except by indirection. The book is badly written, with a developed soap opera of petty jealousy and gossip so typical of today's "baby boomer" generation, where fantasy must make up for the absence of ideas. Yet, not even this slanderous book, which is part of the continuing attacks on the American tradition of science by the British and their friends, could prevent some of the fascinating story of the U.S. Exploring Expedition, 1838-1842, commanded by Charles Wilkes, from poking out from under the gossip.

This is the story of the American discovery of the Magnetic South Pole, with the help of some of the greatest scientists in the world, and the subsequent skillful republican exploitation of aristocratic weaknesses, which kept this important military secret out of the hands of potential and actual enemies of America until after the Civil War.

The United States at that time was very far from being a superpower; it was an embattled republic, unique in the world, and the object of hatred, intrigue, and plans of conquest by the French, British, and other aristocratic circles. The War of 1812, and the British burning of Washington were still fresh in memory. Far-sighted people, such as Alexander von Humboldt, had warned that the British and the French planned to use their Caribbean slave islands to spread slavery throughout the United States.[1]

During the Civil War, the British and the French would collaborate to put an emperor on the throne of Mexico (1864), while the British intervened on the side of the slave holders, with the intention of reversing the success of the American Revolution. Thus, every margin of scientific advantage, superior navigational abilities, and geodesy, might spell the survival of the republic.

Charles Wilkes was born in New York City on April 3, 1798. His great-uncle John is best remembered as "Wilkes No. 45" for his attacks on British government policy in northern Britain in the 1760s.[2] His father, John Deponthieu Wilkes, immigrated to this country during the Revolutionary War.

NOAA Central Library

Captain Charles Wilkes of the Ex.Ex. accomplished "one of the most extraordinary feats of seamanship of all time."

For three years, Wilkes studied with Ferdinand Hassler, the first superintendent of the U.S. Coastal Survey, who had studied and developed new triangulation methods for geodesy work, with the great mathematician, astronomer, geodesist, and republican Carl Gauss. The U.S. Ex.Ex., as the Expedition was known, had been languishing in preparation for 10 years or so, but Wilkes managed to kick things into gear, even before he was appointed to head the expedition.

He went to Europe for several months (where Gauss and Alexander von Humboldt had just established the "Magnetische Verein," (Magnetic Association), to map the geomagnetic field of the entire Earth. There he bought the most advanced instruments available for geodetic and magnetic measurements, including pendulums for measuring changes in the force of gravity.

The leaders of the American republic obviously recognized the strategic importance of science. That is why they sent out *six* ships in the Ex.Ex., whereas Captain Cook had only two; Columbus three; and the Apollo that landed on the Moon was alone.

Barely 40 years old, Charles Wilkes was handpicked by Nathaniel Bowditch, the father of U.S. navigation, and Joel Poinsett, Secretary of War, to command the expedition, going over the heads of many older and more experienced Navy men. They chose wisely.

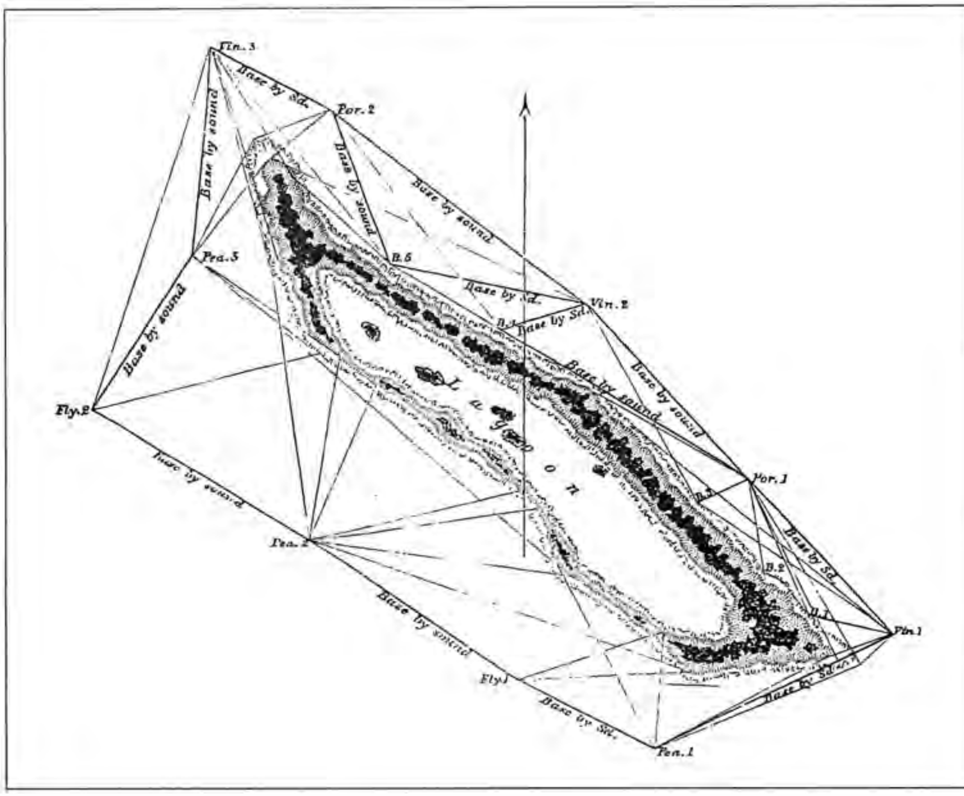
The Greatest Expedition In History!

Here is a summary of Wilkes's success, as recounted by Philbrick (pp. 332-333):

"He and his officers had surveyed dozens of uncharted Pacific islands. They had completed America's first survey of

what would one day become the states of Oregon and Washington. His team of scientists had brought back 40 tons of specimens and artifacts, including 2,000 never-before-identified species. Most impressive of all, he had established the existence of a new continent. Battling icebergs and gale-force winds in his fragile wooden ships, he had charted a 1,500 mile section of the Antarctic coast that still bears his name: Wilkes Land.

". . . [Wilkes] accomplished what has to be one of the most extraordinary feats of seamanship of all time. Braving several gales and countless icebergs, he had sailed his ill-equipped wooden man-of-war 1,500 miles along the windiest, least-accessible coast in the world. And he had done it without losing a single man. . . . [The Ex.Ex. brought back] 4,000 . . . artifacts [more than those] collected during all three of Cook's voyages. . . . Even larger were the number of pressed plants: 50,000 specimens of 10,000 species; more than a thousand living plants, plus seeds for an additional 648 species. 1,150 birds, 134 mammals, 588 species of fish; 300 fossil species, 400 species of coral, 1,000 species of crustacea. . . ."



Wilkes's diagram showing the method he used to conduct a running survey of a coral island in the South Pacific. The survey, of the 7-mile-long island, Wilkes wrote in his Narrative on the Ex.Ex., "was performed in 3 hours and 35 minutes."

Source: *Magnificent Voyagers: the U.S. Exploring Expedition, 1838-1842* (Washington, D.C.: Smithsonian Institution, 1985), p. 172.

The Ex. Ex. brought back so much that the Smithsonian Museum had to be established just to begin to deal with it! The Expedition produced 241 charts (some still used in World War II), charted 280 Pacific islands, 800 miles of the Oregon coast, a 100-mile stretch of the Columbia River, the overland route from Oregon to San Francisco, and 1,500 miles of the Antarctic coast. It also brought back mountains of meteorological, astronomical, magnetic, and oceanographic data, which were later published.

Outfoxing the Imperial Enemy

A heated debate arose as soon as Wilkes arrived in Sydney, Australia, where the French explorer Admiral Dumont d'Urville claimed to have seen the Antarctic continent on Jan. 19, 1840, and set foot there two days later—although he had charted only 150 miles of the coast.

Wilkes said the U.S. Ex.Ex. first saw land on Jan. 17, and that he charted 1,500 miles of the coast. The heated debate that followed included allegations that Wilkes forged entries into his log book to antedate the French.

Another point of controversy swirls around the question of whether Wilkes did indeed give a map of his discoveries to the British explorer Captain James Ross. Given the political importance of priority, to prevent the imperial powers from taking possession of the entire globe, it would seem rather odd on the surface, that Wilkes might have given an accurate map of the area he had charted to Captain Ross, who represented her most imperial majesty, Queen Victoria!

That Wilkes was no fool when it came to the British, is shown by his response to the fact that "a British governor [had just] arrived in New Zealand to make a treaty with the Maori, which began to undermine their sovereignty"[3]. From Sydney, Australia, Wilkes wrote a letter to the Secretary of State, urging that the U.S. Consul there, James H. Williams, be made Consul General for all Polynesia, in order to ensure protection for American interests throughout the Pacific.[4]

But how did Wilkes's correct readings of Brutish imperial ambitions square with giving his map of the 1,500 miles of Antarctic coast to James Ross? And why should Wilkes accompany the map with the following statement: "[A]lthough my instructions are binding upon me relative to discoveries, I am nevertheless aware that I am acting as my govt. would order, if they could have anticipated the case" (p. 186).

Was Wilkes, as Nathaniel Philbrick would have us believe, so stupid and so vainglorious as to betray his country and his mission?

Would such treasonous folly be possible for an American of Wilkes's background, who had been personally charged by Secretary of War Poinsett for this mission? Could this "upstart," who

got the U.S. Ex.Ex. going in record time, while others foundered for a decade, do such a thing? Could the man who was able to survey a coral-reef-ringed island seven and a half miles long, in just 3 hours and 35 minutes have done this—the same man who, on this same trip, had carried out one of the most important political land-surveying tasks in history, of Oregon and the Columbia River, with a view to cutting the British off from access to the Pacific? Impossible!

The Paradox Resolved

When Wilkes gave Ross the map, he put Captain Ross into an interesting bind. Ross would gain nothing important *militarily* from the map, because its very existence meant he could not claim the Antarctic for Queen Victoria. At the same time, the mainland was so difficult to reach, with such an inhospitable climate—as Captain Cook had shown more than once,[5] and as Wilkes, d'Urville, and Ross had themselves just experienced—that it could not possibly serve as a base of operations and resupply for anyone's navy.

So, Wilkes sacrificed a pawn to gain a knight.[6] It is clear that the intelligence services of Britain and France knew all along that one of Wilkes's primary goals was to find the *Magnetic* South Pole, or more broadly, to map the magnetic declination, inclination, and intensity of the entire area. Wilkes had made a well publicized trip to England and continental Europe to get the best instruments! The French explorer d'Urville was in the Antarctic region at the same time as Wilkes, and the British explorer James Ross, whom Wilkes had met in England in 1836, arrived soon after.

Getting an accurate reading of the magnetic map and its fluctuations in the southern ocean was of utmost strategic importance. Probably from pre-historic times, but certainly no later than Columbus's harrowing experience with magnetic variation in the mid-Atlantic, navigators and secretaries of war, had known the potential for mapping the magnetic field of the Earth, so that even in the dark, in a storm, with not a star in sight, and with your chronometer broken, you might be able to find your longitude and latitude. Hence the "Magnetische Verein" set up by Gauss and von Humboldt.

How good were Wilkes's measurements? How good was his map? Did he find the Magnetic South Pole?

One clue comes from an essay on the South Magnetic Pole, published in 1910, by G.W. Littlehales of the U.S. Hydrographic Office, in the *Bulletin of the American Geographical Society* (Vol. XLII, No. 1). There Littlehales describes how he gathered fragmentary information left by Wilkes from Wilkes's nieces, on the basis of which Littlehales was able to calculate a fairly precise (like the North Magnetic Pole, the South Magnetic Pole also wanders) position of the South Magnetic Pole at the time that Wilkes took the measurements—that is, 66 degrees, 47 seconds S., 148 degrees, 10 seconds E.

Europe and the U.S. vs Britain

Like the case of the purloined letter which was sitting in front of everyone's nose (made famous in the Poe story), Wilkes had clearly made a very good map. He found, and knew that he had found, the South Magnetic Pole, but he blurred things to keep the enemy guessing. He must have found the pole, not by landing on it—as only a fool would demand—but by triangulation and by measuring magnetic dip, which tends increasingly toward the vertical near the pole.

The need to keep the *details* of this secret as long as possible, must be the reason that his *Physics* book was "inexplicably never published, out of a series of 25 books on the findings of the Ex.Ex., which Wilkes published. Giving Ross a map of the land, by itself, without the magnetic measurements, would mean little or nothing—except that it might lull Ross into thinking that he was dealing with his foolish country cousin.

As it was, Ross voiced his doubts in public "about all of the American's findings because of certain apparent errors on the chart."[7] Certainly the British were not satisfied with Ross's results, but found it necessary to send out another expedition, led by T.E.L. Moore in the *Pagoda,* 1844-1845, to do more magnetic surveying.

But this secret was not kept from the transatlantic conspiracy, the allies of the American republic in Europe, the heirs of the League of Armed Neutrality. And it should not come as a surprise that it was the circles of Germany who kept Wilkes's name and exploits alive. As Philbrick writes: "With the exception of the Expedition's own charts, no British or American maps referred to Wilkes's findings throughout the 1860s. If it hadn't been for German mapmakers, who were the only ones to record the American claims and to adopt the name of Wilkes Land, all trace of Wilkes's achievement might have been lost" (p. 362).

The rest is disinformation, red herrings, and dissimulation by Wilkes, brilliantly exploiting the aristocratic weaknesses for gossip, and egotistic priority claims, to muddy the waters, and keep the secret which was of such importance to the sheer survival of the fledgling republic.

When Wilkes returned from the Expedition, he began to work with Alexander Dallas Bache on the U.S. Coastal Survey, an invaluable instrument for the Union naval blockade during the Civil War that broke out just as the survey was completed. To cap the irony, Wilkes, whose name ought to be a household word, is still very little known in America today. Those few who know his name, do so from the Civil War, when on Nov. 8, 1861, Wilkes as Captain of the *San Jacinto,* in an act of hubris completely coherent with his Antarctic work, seized two Confederate commissioners, James Mason and John Slidell, from the British vessel *Trent,* and carried them to Boston—an act which boosted Union morale at a crucial point during the war.

Notes

1. Alexander von Humboldt, 1811. "Essai politique sur le Royaume de Nouvelle Espagne" (Paris: F. Schoell).
2. Charles's great uncle John Wilkes who was a member of the House of Commons, and editor of the *North Briton* newspaper, was thrown in prison for issue No. 45 (published April 23, 1763), in which he called for reforms of the British government. A letter of support was sent from a group in Boston signed "The Friends of Liberty, Wilkes, Peace and Good Order assembled at the Whig Tavern to the number of forty-five and upwards." Boston's Sons of Liberty dated their founding from the date of that letter of support, which was May 1763.

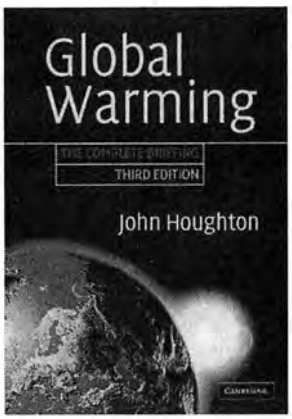
   See *The Flags of the Sons of Liberty,* by Richard R. Gideon, and "Charles Wilkes: A Biography" by Joyce Leonhart, in *Magnificent Voyagers: the U.S. Exploring Expedition, 1838-1842* (Washington, D.C.: Smithsonian Institution, 1985), p. 189.
3. "Charles Wilkes As Diplomat", by E. Jeffrey Stann, in *Magnificent Voyagers,* p. 217.
4. *loc. cit.*
5. See "The Suppressed Story of Captain Cook's Second Voyage," by Rick and Lenore Sanders, *21st Century,* Winter 2001-2002.
6. There was some reason to think the pawn was poisoned: Ross complained that the map had mistakes in it. See *Magnificent Voyagers,* p. 217.
7. *loc. cit*

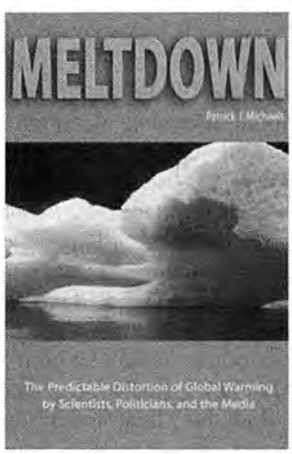
The Lowdown on the Meltdown

by Howard Hayden

Global Warming: The Complete Briefing, Third Edition
by Sir John Houghton
New York: Cambridge University Press, 2004
Paperback, 351 pp., $45.00

Meltdown: The Predictable Distortion of Global Warming by Scientists, Politicians, and the Media
by Patrick J. Michaels
Washington, D.C.: Cato Institute, 2004
Hardcover, 271 pp., $24.95





Sir John Houghton has famously told the world that global warming is a weapon of mass destruction, a far worse threat than terrorism. His humorless *Global Warming: The Complete Briefing* is several notches above Al Gore's *Earth in the Balance* and Stephen Schneider's *Laboratory Earth,* but it's a horror story nonetheless.

Patrick J. Michaels's *Meltdown: The Predictable Distortion of Global Warming by Scientists, Politicians, and the Media* is a welcome antidote to global warming hype. Read the title carefully. It should not be news to anybody that politicians and the media distort global warming, but Michaels asserts that scientists are also guilty—and provides the data to make his case.

The first five chapters of *The Complete Briefing* are the ones of interest. These 115 pages have a good summary of data and models used by the IPCC. Then the speculation and carping begin with Chapter 6 and continue for the next 200 pages. Here we can learn about the usual litany of horrid things that will happen to the Earth if we continue to cause global warming: more hot weather, more extreme hot weather, more rain, less rain, more tropical disease, changes in ocean thermohaline circulation, and rising sea levels. Houghton cites religious reasons (some taken from Al Gore) for being better stewards of the Earth.

As a late colleague used to comment, the first step toward understanding something is to memorize the facts. As the useful facts are in the first five chapters, I shall concentrate on them, leaving the speculative parts to those who are comfortable playing 5-card stud with 52 cards wild.

It is not high temperature, but temperature *differences* that drive the winds. If the entire Earth were at some uniform but extremely elevated temperature like 50°C, there would be no storms whatsoever. None. On the other hand, a cyclonic storm has existed on ultra-cold Jupiter for at least 300 years. This is a matter of elementary thermodynamics.

All global circulation models predict that global warming will be greatest at the poles, and basically trivial in the tropics. That is, all global circulation models predict a *reduction of temperature differences,* hence a reduction in the frequency and severity of storms.

That much said, it is hard to understand why Houghton goes out of his way to emphasize "The remarkable last decades of the 20th Century." One page is devoted to a map showing severe weather events in 1998. His purpose is clearly *not* to say that we're going to see a decrease in such weather-caused devastation, but rather to produce a frightening scenario for the stupid but numerous.

Houghton's horror story continues with the usual litany of weather-related insurance losses, which have increased much faster than generic insurance losses during the last half-century. There is not a word in the book attempting to produce an honest analysis of this oft-repeated insurance story. For example, because air conditioning has made the state habitable, the population of Florida has quadrupled since 1950, largely by wealthy and semi-wealthy retirees, who have built expensive homes in hurricane territory. For that matter, Houghton presents no actual data on hurricane frequency or intensity, but says incorrectly that there are no clear trends in the last half of the 20th Century.

Rising sea levels, of course, don't have anything to do with violent weather. Houghton tells us, correctly, that sea level rose between 10 and 20 centimeters during the 20th Century, and he implies that rising seas caused by further global warming will inundate lowlands everywhere. But it has also risen 100 meters—10,000 centimeters—since the last Ice Age, when a tremendous amount of water was locked up in ice sitting on land. Of course, the 10,000-cm rise happened before the industrial revolution, but everything since is obviously caused by mankind.

It is interesting to look at Houghton's discussion of how the global average temperature is measured. ". . . All the observations, from land stations and from ships, are then located within a grid of squares, say 1° of latitude and 1° of longitude, covering the Earth's surface. Observations within each square are averaged; the global average is obtained by averaging (after weighting them by area) over the averages for each square."

That all sounds simple and straightforward. A 1°-by-1° region is nearly square at the equator (roughly 70 miles by 70 miles), but is wedge-shaped nearer the poles. Presumably, this inequality in area is what is meant by "after weighting them by area," although Houghton provides no explanation. But that is hardly

the problem. To imply that there are regular temperature readings in every 1-degree square of the Earth is way beyond absurd. By and large, thermometers are where people are—in heavily populated areas likely to have a heat-island effect.

There are huge uninhabited regions on this planet. It is also a fair bet that there are millions of square miles whose average temperature is inferred from no more than a half-dozen thermometers. Moreover, assessing the temperature of the ocean accurately is even more perilous, because there has been no consistency in the method of taking readings (near ship, far from ship, ahead of ship, behind ship, depth of sampling, time of day) . . . .

Microwave sounding units on satellites, on the other hand, sample *all* areas of the Earth, and do *uniform* sampling of temperature. Readings taken by satellites always agree closely with readings of the same region taken by weather balloons; therefore, the calibration of instruments is assured. But the worldwide average temperature as taken by satellite does not show the recent rapid upturn of worldwide "average" temperatures that is inferred from ground-based thermometers.

Houghton acknowledges this difference, yet builds his entire book around the infamous "hockey-stick" graph (p. 85) that actually denies that there ever was a Medieval Warm Period or a Little Ice Age. The absence of these well-known climatic events ought to have made Houghton very suspicious. (In fact, there were numerous statistical errors made during the construction of the hockey-stick graph.) But how could you write a horror story about an Earth that is warming slowly, and on which there will be fewer and weaker storms?

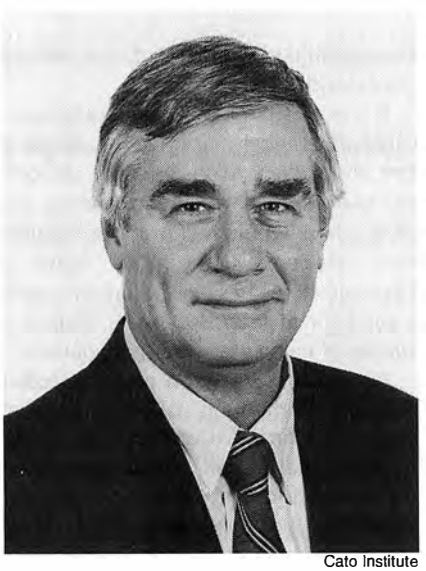
Meltdown Refreshing

Meltdown is an entirely different kind of book. With acidic humor and mountains of facts, Michaels thoroughly demolishes the standard shibboleths of global warming. For example, he shows—using uncontroversial data—that Greenland's temperature has been slightly declining since its highest temperatures in the late 1930s and early 1940s; that Kilimanjaro's glacier has been retreating since at least 1912, and the temperature at the peak has recently been *decreasing;* that precipitation in

IISD

Sir John Houghton on global warming: A greater threat than terrorism.

the United States has been increasing since the late 1800s; that at least half of the global warming occurred before 1940, well before any perceptible increase in CO_2 levels; that maximum wind speeds of Atlantic hurricanes have *decreased* since record-keeping began in the 1940s; that the annual number of hurricanes making landfall has generally *decreased* since 1900; that sea level has *fallen* around Tuvalu (about which island the news media have shed many tears); that the "heat index" (an as-if



Cato Institute

Patrick Michaels on global warming: Political hogwash.

temperature, calculated from actual temperature and relative humidity) will *not* increase in those areas where temperature and humidity are high; and many, many others.

Importantly, Michaels makes three points: (1) the Earth is, in fact, warming up; (2) the warming is slight and manageable; and (3) there is nothing we can do about it.

Michaels begins by looking at the science. He points out that the temperature rise of the Earth is proportional to the logarithm of the CO_2 concentration. I wish the book had a brief explanation for this behavior; Michaels simply refers to a (refereed) paper he and three colleagues published in *Climate Research* that gave the reasons and presented actual data in support.

The global-warming modellers assume that the CO_2 concentration is rising exponentially at 1 percent per year. But even if that gross overestimate were true, then the temperature would rise *linearly* with time, because of the logarithmic response of temperature to concentration. But the CO_2 concentration has risen at less than exponential rates for three decades—a fact ignored in almost all global circulation models—so that the rate of temperature rise should decrease.

Michaels tells us why most of the CO_2-induced global warming must occur in the Arctic regions, primarily at night and in winter. The most important greenhouse gas in the world, by a factor of 10, is water vapor. Add a little CO_2 in the humid tropics, and the additional blanketing effect is negligible. Add a little CO_2 in the polar regions where there is almost no H_2O at all, and the blanketing effect is noticeable.

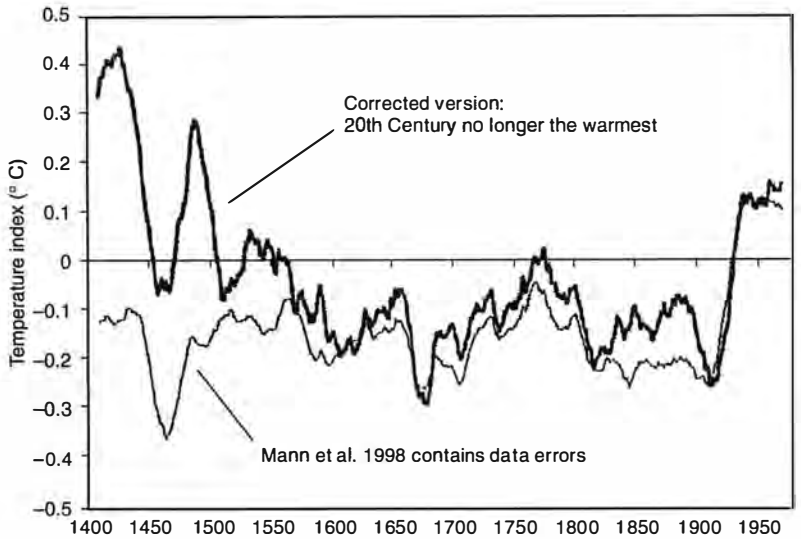
Houghton worries at length about heat stress, painting a picture of people and livestock dying, tropical diseases becoming rampant, and tourists "seeking other destinations"—presumably no New Yorkers will visit the Bahamas in January. But how bad can the heat index become in high-humidity, low-latitude coastal areas? In fact, it can hardly increase, because more heat simply causes a little more water to evaporate, rather than raising the temperature. Using numerous examples, Michaels shows that the heat-stress argument is so much hogwash.

Glaciers and ice caps are dynamic

things. There is some evaporation even at extremely low temperatures; there is melting, and there is snowfall; the balance determines whether glaciers grow or recede. Absent any mechanism to replace evaporated and melted ice, *all* glaciers and ice caps in the world would eventually be gone. Kilimanjaro's snows, for example, are in decline because of a decline in precipitation, and most assuredly not because of rising temperatures.

While *The Complete Briefing* goes into a rant about the supposedly devastating effects of global warming, *Meltdown* provides a bleak picture of global warming science and its practitioners. For example, the Intergovernmental Panel on Climate Change publishes a large array of global warming scenarios, asserting that all of them (even extremely unlikely ones) are *a-priori* equally likely; averaging them leads to a temperature rise that is *triple* the likely value. (It's vaguely akin to averaging Bill Gates's income with mine.) Michaels tells us that *The U.S. National Assessment of Climate Change* (USNA) was monumentally political. "This tortuous bureaucracy was larded with political appointees at all levels and served to ensure that the proper individuals ultimately produced the USNA." Similarly, the United Nations Intergovernmental Panel on Climate Change (IPCC) has more than 200 "lead authors," of whom only a third are climate scientists.

Michaels blames the system that finances research because it gives rewards to scientists for producing extreme scenarios that lead to scary headlines, hence to Congressional demands to throw more money to the researchers. There is much to be said for that point of view.



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.

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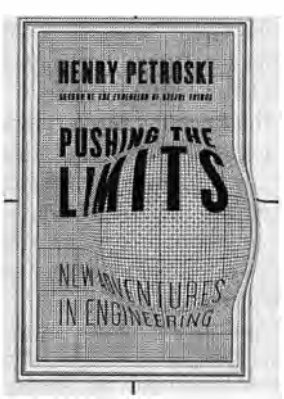
The Beauty of Engineers' Dreams

by Marsha Freeman

Pushing the Limits
by Henry Petroski
New York, Alfred A. Knopf, 2004
Hardcover; 288 pp., $25



Many of the 11 books that Civil Engineering Professor Henry Petroski has written have exposed the nontechnical reader to the fascinating history and future of designing and building great engineering projects. His vantage point reflects that of a bright young man growing up during the building of the interstate highway system, the construction of the first nuclear power plants, and the national mobilization to land a man on the Moon.

Henry Petroski elegantly intertwines details about the technical requirements of projects such as bridges, with the stories of the men who designed them. He reaches back into history to provide examples of, and give perspective to, engineering projects of the modern age.

What is so attractive about his work, is that it recalls to us the time before environmentalists stopped construction of almost everything, before people had been brainwashed into believing that technology is dangerous, the time when the United States believed that sharing the latest technologies with developing nations was its proper and historic role.

A Renaissance View

In this newest of his works, Petroski reaches back to a Renaissance view, without so stating—a reflection perhaps of Leonardo da Vinci's impact on engineering—that great "practical" engineering works by man, are also beautiful. In his preface, he states, "The ingenious creations and elegant solutions of engineers are also works of art and inspiration: an Eiffel Tower or a voyage to the Moon lifts everyone's spirits."

Petroski quotes American Joseph Penell, who illustrated European travel articles and books, that "Great engineering is great art." Penell depicted the Panama Canal as it was nearing completion, and the partially completed New York Hell Gate and Delaware River bridges. "I understand nothing of engineering," he said, "but I know that engineers are the greatest architects and most pictorial builders since the Greeks."

In his chapter on "Art in Iron and Steel," Petroski describes the work of artists who depicted various ages of American engineering marvels, from 18th Century bridges, to 19th Century railroads, to Henry Ford's 1927 city-sized River Rouge automobile manufacturing complex south of Detroit. The beauty was in the architectual design, reflecting the divine proportion and least-action principles in nature, the concept of man's mastery over the obstacles in his environment.

In this way, art can reflect not only a particular engineering accomplishment, but an era, as seen in Margaret Bourke-White's series of photographs of the dams built by the Public Works Administration during the Great Depression. The dams transformed not only the landscape, but the people who built them.

The Roebling Masterpiece

Nothing represents the triumph of man over nature more than his efforts to build bridges, or "fixed links" (which also includes tunnels), to allow the expansion of his activities to areas previously inaccessible.

New York is the great city of bridges, out of necessity, to connect its three main islands. When John A. Roebling was faced with spanning the East River, the technical challenge was to allow shipping to operate unobstructed. This meant a suspension bridge, based on the stringing of steel wire cables in the shape of a catenary (what Petroski calls "a well-proportioned sag"), from two tall towers, anchored on each side of the River.

clipart.com

Petroski writes of the Brooklyn Bridge: "It is so grand in its execution that it is easy to forget that the bridge was built for the city, not the city for the bridge."

Petroski writes, "Rather than design a purely utilitarian structure, Roebling produced a masterpiece." The tall arched stone towers Petroski describes as "triumphal." A bridge deck was built, not only for horses and carriages, but also for people. The elevated pedestrian walkway puts those on foot above the road traffic. Petroski states: "A walk across the Brooklyn Bridge is one of the world's great pedestrian experiences."

The skyscrapers of Manhattan "appear through the screen of steel as a great backdrop for the bridge itself. It is so grand in its execution that it is easy to forget that the bridge was built for the city, not the city for the bridge."

Pushing the Limits

Whether architecture or engineering, bridges and other infrastucture masterpieces have not always succeeded. The United States has more than half a million bridges, Petroski reports, and a small number of them have failed.

"The very act of designing a bridge involves creating what does not exist, at least in the exact form required for a new location," Petroski explains. "Engineering design is a self-referential process, and there is no differential equation epitomizing bridgeness to which one need only append appropriate boundary conditions to find a unique or even just a neat mathematical solution.

"There is no science of bridges, nor can there be, if science means the mastery of what already exists." In this way, engineers are often "pushing the limits," by designing artifacts that are "fraught with conflicting objectives," under specific conditions never faced before.

Petroski documents how, over the past decades, many of the engineering challenges have been in Asia, and still are. These include the longest suspension bridge in the world in Japan; the huge Three Gorges Dam in China; and the world's tallest skyscraper, the Petronas Towers, in Malaysia.

In 1954, German-born science writer Willy Ley, who moved to the United States in the 1930s, wrote a book titled *Engineers' Dreams*. Henry Petroski reports that when he gives lectures, often he is asked about a book "published in the 1950s" about great engineering projects. People remember reading about a tunnel under the English Channel, a dam across the Straits of Gibraltar, and others.[1]

Fittingly, Petroski devotes a chapter of his new book to Willy Ley—his imagination, his lucid and exciting writing style, and his dreams of how engineers could change the world. Ley's book, and its author, Petroski writes, "deserve to be remembered."

Henry Petroski's new book is a valuable addition to the legacy of engineers' dreams.

Notes

1. There is a chapter about Willy Ley in *How We Got to the Moon: the Story of the German Space Pioneers*, by Marsha Freeman (Washington, D.C.: 21st Century Science Associates, 1993).

THE WORST FLOOD CATASTROPHE IN HISTORY

The World Needs a New Economic System!

by Helga Zepp-LaRouche

This statement was issued by Helga Zepp LaRouche, founder of the Schiller Institute, on Jan. 3, 2005

The biggest aid operation of all times is now beginning, to face up to a gigantic task: to recover over 100,000 bodies, in order to prevent the spread of diseases that would multiply the number of victims; to supply about 2 million homeless; and to reconstruct 60,000 villages, infrastructure, and agricultural areas. Just to restore the conditions existing before the flood, will require minimally billions of dollars in the double-digit range. The initiative of German Chancellor Schröder for a debt moratorium for Indonesia and Somalia is a step in the right direction.

But something much more fundamental is needed, if a repetition of catastrophes of this magnitude is to be prevented. We have to distinguish between those aspects of natural disasters that cannot be prevented, and the effects of the inadequate development policies of the recent decades. Before the present flood wave, the most dramatic tsunami in history was that which was caused by the explosion of the volcano Thera on what today is called Santorini Island, in 1628 B.C., destroying the Minoan culture. Therefore, we have to assume that more tsunamis, as large as that one, or as the one just suffered in Southeast Asia, are possible.

An early warning system for the threatened areas can be installed relatively simply, and is not very expensive. Not to mention that a phone call from the U.S. State Department—which had been informed of the quake as soon as it happened—to the governments of the countries threatened by the tsunami, would also have been very cheap. What, for heaven's sake, prevented the U.S. government from sharing this information with the relevant governments? This question will preoccupy the world intensely!

But the decisive point, for which the leading international financial institutions bear a massive guilt, is the scandalous dimensions of the neglect of development in recent decades. The tourist boom in countries like Thailand, Sri Lanka, or the Seychelles, which has granted a windfall of profits for tourism enterprises and international resort chains, cannot cover up the reality that the living conditions of the indigenous populations have not really improved, and that the countries involved have not really developed economically. Quite the contrary, especially the "holiday paradises" have proven themselves to be death traps for many so-called "natives," and for tourists.

EIRNS

Helga Zepp-LaRouche at the Eastern Terminal of the New Eurasian Land-Bridge in Lianyungang, China, 1998.

The fact that under the system of globalization, one-third of humanity is permanently undernourished; that a billion of those are children living in poverty; that every day, 50,000 human beings die of starvation and preventable diseases; and that whole continents are threatened in their very existence, is proof of the absolute failure of the present world order. Just because the G-7 governments—Germany, France, Great Britain, the United States, Canada, Italy, and Japan—have submitted to the dictates of the international financial oligarchy which profits from globalization, and because the majority of the population demonstrates an unbelievable moral indifference toward the poverty of 4 billion people, does not mean that the present world order has not failed.

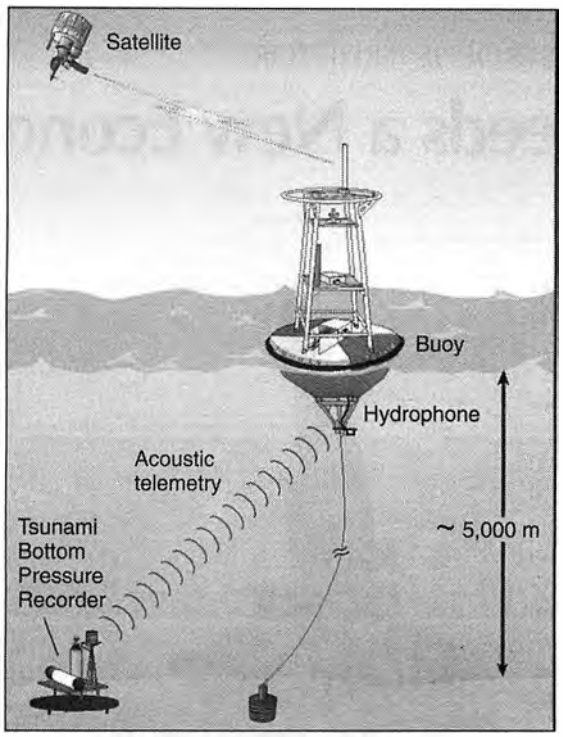
Today's Moral Failure

The entire scope of the moral failure becomes obvious, when this attitude is compared to the totally different attitude predominant in the 1950s and 1960s. Then, it was a general axiom of thought, that the undeserved underdevelopment of the developing countries, which was regarded as the result of centuries of colonialism, must be overcome, as soon as possible, by development programs. In the United Nations, people talked about "development decades," within which a certain progress, raising the standards of living and life expectancy, was to be accomplished. And for Pope Paul VI, underdevelopment was so unbearable, that he lashed out against poverty in his ardent appeal to the world population,

in his encyclical *Populorum Progressio* ("On the Progress of Peoples"), as a situation "whose injustice cries to heaven."

But with the paradigm change that has, since the late 1960s, turned societies in the G-7 nations away from being producer societies into consumer societies—away from the production of real goods, and toward speculation and a pure money economy, away from the common good, and toward a society that is egotistically competitive and rampantly pleasure-seeking—with this shift, the attitude toward the so-called "Third World" changed, too. Now, it was considered good, if everything there were as cheap as possible, because a stay at a five-star resort on the beach was less expensive, since these "natives" got oh-so-wonderfully-low wages.

In more than one way, the fantasy world of our consumer- and pleasure-oriented society has suffered a reality shock. In its typically cynical way, the German daily *Frankfurter Allgemeine Zeitung* asked, on Dec. 29, what an Indian fisherman and a German tourist have in common? Normally, nothing—but now, they share the same mass grave. . . . If we can read any meaning at all into this horrible flood catastrophe in Southeastern and Southern Asia, then it is only by viewing it as a sign from heaven that man cannot violate Creation's order, for a long time, by treating the larger part of humanity as a second class of human beings, without provoking Nemesis.



NOAA'S TSUNAMI WARNING SYSTEM, DART

The DART tsunami warning system for the Pacific Ocean is what is needed now for the Indian Ocean basin. DART, or Deep-ocean Assessment and Reporting of Tsunamis, consists of anchored seafloor bottom pressure recorders, which are linked to a buoy moored on the ocean surface. Data are transmitted acoustically from the seafloor to the surface buoy, and then relayed in real time via a GOES satellite link to ground stations. In its standard mode, the system transmits four 15-minute average sea surface height values.

When an event is identified, the system transmits values every 15 seconds for several minutes, and then it transmits 1-minute averages. The system can detect tsunamis as small as 1 cm.

The system of globalization is presently in the end phase of its systemic collapse. The free fall of the U.S. dollar is only one symptom of this. When the leading "analysts" speak of a Hiroshima for the financial system, these days, of an Armageddon, of a coming avalanche, of the end of the system—then, everyone should know what hour has been rung: The great crash of 2005 has come.

A Way Out

But, there is a way out.

(1) The G-7 nations must, together with Russia, China, India, and other nations of the world, effect a total reorganization of the hopelessly bankrupt global financial system, and replace it with a New Bretton Woods system in the tradition of Franklin D. Roosevelt.

(2) Not only the debts of Indonesia and Somalia should be eliminated, but those of the whole developing sector—because they cannot be paid anyway.

(3) The derivatives and currency speculation, which, according to the most recent report of the Bank for International Settlements, has reached the unbelievable volume of $2,000 trillion, must simply be wiped out, and be made illegal by agreements among governments. Fixed exchange rates must be introduced, in order to make speculation against currencies and national wealth impossible.

(4) The creation of new credits for productive investments must be taken away from the control of supposedly "independent," that is, private, central banks, and brought under the control of sovereign governments.

(5) Part of the New Bretton Woods agreement, must be the creation of some $2 trillion in new, productive credits for the G-7 nations, to provide for full employment in the context of the building of the Eurasian Land-Bridge, that is, the infrastructural integration of Eurasia.

(6) In order to embark on the urgently needed overcoming of the underdevelopment of vast parts of the developing sector in Asia, Africa, and South America, in the context of the building of the Eurasian Land-Bridge as an engine for the reconstruction of the world's economy, an "International Development Bank" must be part of the agreement, which will provide at least 500 billion euros annually for clearly defined development projects.

(7) Lyndon LaRouche and the international movement named after him, have, since the early 1970s, worked out concrete development programs for Africa, South America, the Pacific Basin, India, Southwest Asia, and for Eurasia; programs which, taken together, could provide a concrete basis for a New and Just World Economic Order—immediately!

Only if the interiors of the nations of Africa, Asia, and South America are developed to a dignified level, will we be able to reduce the effects of future natural disasters to a minimum.

When you think about these questions, which will decide the future of the 21st Century, don't think just about yourself. Think about that which you can contribute, so that humanity becomes worthy of its name!

Join our movement for a New and Just World Economic Order!

For more information: 1-888-347-3258 **www.schillerinstitute.org**

UNDER-DEVELOPMENT CAUSED TSUNAMI CATASTROPHE

The tsunami could not have been stopped, although better warnings could have been given. But the lack of basic infrastructure in those countries relegated to the status of vacation paradises for rich tourists, contributed to tens of thousands of unnecessary deaths.

In the call for "A New World Economic System" (page 87), Schiller Institute founder Helga Zepp-LaRouche describes a way out of the system of globalization, which is leading us all to disaster.

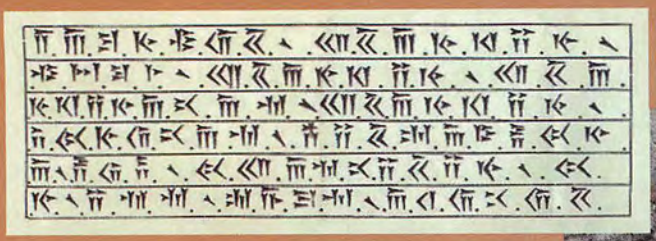
Photographer's Mate 3rd Class Travis M. Burns/U.S. Navy Photo

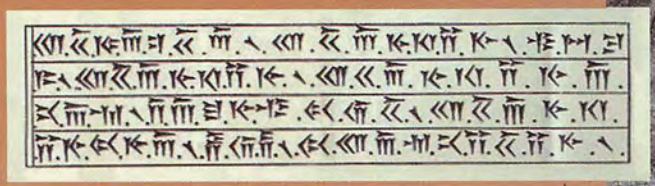
A forklift is craned aboard the USS Essex in Bahrain, Jan. 10. The ship is being loaded with equipment and supplies bound for Operation Unified Assistance to help the tsunami-hit area in Southeast Asia.

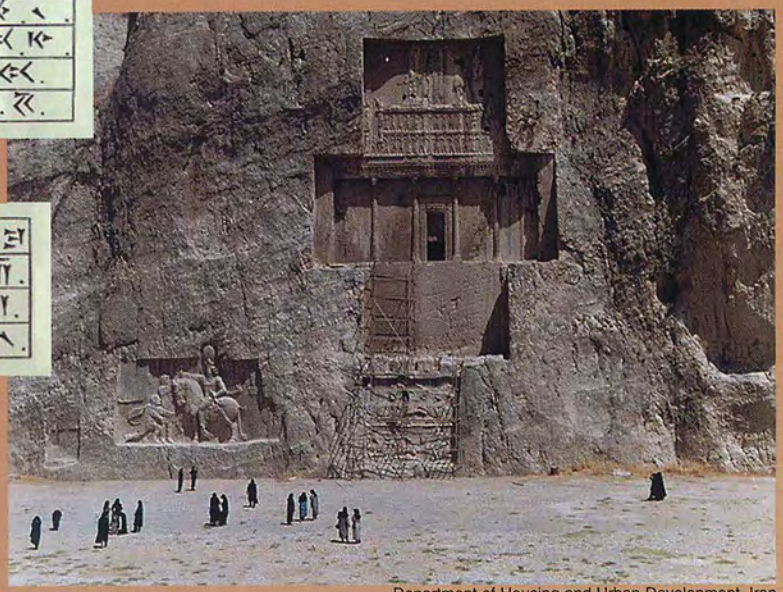
EIR

The Eurasian Land-Bridge, the centerpiece of economic development for the land mass containing over three-fourths of the world's population. Only the most important trunk lines are shown here. "Development corridors" extending for 150 kilometers to either side, and the spurs branching out from the main system of this network for high-speed transport, will be the basis for a Eurasian economic miracle in the early 21st Century under the LaRouche plan.

In This Issue







Department of Housing and Urban Development, Iran

European travellers to Persia in the 17th and 18th centuries had copied inscriptions from ruins and bas reliefs, like this one at Persepolis, but the script remained unknown until Grotefend's work. Inset are two of the cuneiform inscriptions that Grotefend deciphered.

HOW GROTEFEND DECIPHERED OLD PERSIAN CUNEIFORM

Georg Friedrich Grotefend took on the challenge of deciphering the cuneiform script of Old Persian. He bet a colleague that he could do it, and he succeeded—in record time. Muriel Mirak-Weissbach tells how he did it, working in the rich cultural environment of Göttingen University in the early 19th Century.

Dan Sturman

LaRouche Youth Movement members are shown the stamping press in the Ohio State University Materials Processing Laboratory.

SECRET OF LOST CIVILIZATION DISCOVERED IN UNIVERSITY BASEMENT

While campaigning in Ohio, members of the LaRouche Youth Movement discovered a well-kept secret: the Ohio State University Materials Processing Laboratory. In the "Science and the LaRouche Youth Movement" section, Dan Sturman explains the machine-tool principle, which must be revived for our civilization to survive.

SCIENCE and the **LaRouche Youth Movement**