21st CENTURY SCIENCE & TECHNOLOGY

FALL 2001 www.21stcenturysciencetech.com $3.50/IN CANADA $4.50

HOT AIR OVER WIND ENERGY

Hyper-X

Into Space With Wings!

- The Paradoxes of Moving Electricity
- Did Ancient Navigators Measure Longitude?

13>
0 74470 74216 6

Expand your world view with

21st CENTURY SCIENCE & TECHNOLOGY

NASA

The International Space Station, backdropped against black space, was photographed with a digital camera from the Space Shuttle Discovery, March 18, 2001

Subscriptions

U.S.—6 issues for $25
Foreign—6 issues for $50

Books

The Holes in the Ozone Scare: The Scientific Evidence That the Sky Isn't Falling
by Rogelio A. Maduro and Ralf Schauerhammer
$15 each, plus $3 shipping
OR $10 postpaid with a subscription

How We Got to the Moon: The Story of the German Space Pioneers
by Marsha Freeman
$15 each, plus $3 shipping
OR $10 postpaid with a subscription

Global Warming: The Rest of the Story
by Dr. Gerd Weber
$11 each, postpaid
OR $8 postpaid with a subscription

Hermann Oberth: The Father of Space Flight
by Boris V. Rauschenbach
$15 each, plus $3 shipping
OR $12 postpaid with a subscription

Give *21st Century* subscriptions and gifts

ORDER FORM

Enclosed is $_____for:

____ 6 issues/ U.S.— $25
____ 6 issues/ foreign airmail—$50
____ 12 issues/ U.S.—$48
____ 12 issues/ foreign—$98

____ $10 for *The Holes in the Ozone Scare* with a subscription
____ $18 postpaid for *The Holes in the Ozone Scare*
____ $10 for *How We Got to the Moon* with a subscription
____ $18 postpaid for *How We Got to the Moon*
____ $8 for *Global Warming* with a subscription
____ $11 postpaid for *Global Warming*
____ $12 for *Hermann Oberth* with a subscription
____ $18 postpaid for *Hermann Oberth*

Please print or type name and address of gift recipients on a separate paper. Gift cards are available.
Note: Back issues are available at $5 each ($8 foreign)

Name _____

Address _____

City _____ State _____ Zip _____

Daytime telephone (_____) _____ e-mail _____

Send check or money order (U.S. currency only) to:
21st Century, P.O. Box 16285, Washington, D.C. 20041.

New: Subscribe online! www.21stcenturysciencetech.com

21st CENTURY
SCIENCE & TECHNOLOGY

Vol. 14, No. 3 Fall 2001

Features

Many of today's negative images of radiation are related to fear of adverse health effects. Yet, we are surrounded by natural radiation, and, as nuclear engineer Jerry Cuttler explains, in the Nuclear Report, the evidence shows that low-dose radiation is beneficial to human health.

Here, one of the first radiographs (a hand) by Wilhelm Roentgen, the discoverer of X-rays.

News

Departments

On the cover: Illustration of the Hyper-X taking off, courtesy of NASA. Cover design by Alan Yue.

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year in 2000, every third month, by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 20175. Tel. (703) 777-7473.

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

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

21st Century is dedicated to the promotion of unending scientific progress, all directed to serve the proper common aims of mankind.

Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

We are not responsible for unsolicited manuscripts.

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

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

Printed in the USA ISSN 0895-682

www.21stcenturysciencetech.com

Why You Don't Believe Fermat's Principle

Confusion over the meaning of the term *universal physical principle* may be more prevalent in science today than at any time in history. In former times, although great differences existed on this matter, they were usually discussed. Today, we don't even bother. Hence, the most contradictory views coexist within the body of knowledge mis-termed modern science.

One of the clearest dividing lines is over the matter of *intention* in nature. Despite the overwhelming evidence of a purposefulness in natural development, the modern view has replaced the idea of *intention* with that of *mechanism.* A theory is called scientific if it provides a credible mechanism, or *model,* to describe an observable natural phenomena.

In one such model, dead objects (often called particles) are assumed to exist and are assigned certain properties, such as *attraction, repulsion,* or *inertia,* which must be assumed as axiomatic. These objects exist in an empty, triply-extended container, called space, to which certain self-evident properties are attributed, while a fourth dimension, called time, extends linearly into the before and after. In another version, the space is not empty, but filled with a substance capable of transmitting waves, which replace the particles as the self-evident elementarity.

In modern times, we have added various complex variations to these mechanistic systems. In one, the ether disappears, but the waves, and particles, still exist. And there are others, but none that has challenged the essential premises of mechanism.

Wide acceptance of a fraudulent version of the history of science has allowed the flourishing of the modern prejudice that the method of mechanism has produced scientific discovery. (We can show that it has never led to scientific discovery, but only to its suppression.) We take the case of Fermat's Principle of Least Time to help the modern reader to understand that a true universal physical principle will be an expression of *intention* in the universe. A close examination of the criticism to which Fermat's Principle was subjected by the Cartesians, will help the reader to see the prejudices he likely brings to the subject.

Snell's Discovery

The law of reflection of light, that the angle of incidence equals the angle of reflection, was known in classical times. Heron of Alexandria recognized that this law obeyed a minimal principle; that is, that were the angles to differ from each other, the time and distance of travel of the light would not be the least possible.

The law governing the refraction of light proved more difficult to discover. When a ray of light passes from one medium to another, it is bent (refracted). If the passage is from a less dense to a more dense medium, the light bends toward the normal to the surface forming the boundary between the two media. However, the angle of refraction varies, in some non-linear way, with the angle of incidence. The problem of lawfully determining this angle had been under investigation since Classical times. Neither the great optical theorists of the Arab renaissance, nor those of Europe could solve it.

Finally, in 1621, Willebrord Snell, a leading mathematical physicist of the Dutch republican tradition, found the solution. The light ray is refracted in such a way that the *sines* of the angles of incidence and refraction remain in the same proportion for any given pair of media (see Figure 1).

Snell's discovery was welcomed by

René Descartes (1596-1650), the leader of a philosophical school which proposed that all natural phenomena could be explained by mechanical causes. In fact, Descartes so welcomed the discovery that he claimed it for his own, and his writings being more widely read than Snell's, Descartes was thought to be the discoverer of the law, until the matter was cleared up after his death.

Descartes was not content, however, to express the law as Snell discovered it. It was necessary to fit it into his mechanistic philosophy of nature, in which he represented light as consisting of ballistic particles. In order to thus account for the law of refraction, Descartes had to make the unusual assumption that the particles speed up when they pass from a less dense to a more dense medium. This seemed absurd to many. However, as no one was able to accurately measure the velocity of light in its passage from one medium to another, this assumption was not finally disproven experimentally until the middle of the 19th Century, when Leon Foucault and Armand Fizeau designed an experimental apparatus which proved Descartes wrong.

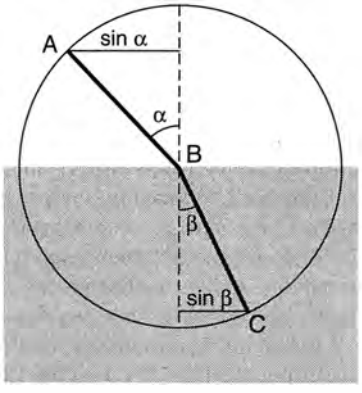


Figure 1
SNELL'S LAW OF SINES
When a light ray passes from a rarer to a denser medium, it is bent toward the normal (dotted line). The relationship between the angles α and β was not known, until Willebrord Snell discovered in 1621 that the sines of the angles maintain a constant proportion for any given pair of media.

Fermat's Principle

Pierre de Fermat (1601-1665) was one of those classically educated geniuses, who, like Ampère, never went to college. Having received an early education in Greek and Latin, Fermat read the mathematical classics of antiquity in the originals, and so developed his mind. (Ampère never even went to elementary school, but learned by reading in his father's library; he taught himself Latin at the age of 11, in order to be able to read Bernoulli's calculus.)

Fermat did not believe Descartes's assertion about the velocity of light. After a long and fruitless correspondence with the followers of Descartes, he came upon a new flank of attack. In 1657, in a letter to Cureau de la Chambre, Fermat stated for the first time his idea that the law of refraction might be deduced from a minimum principle, like that which Heron had noted for reflection.[1]

In a letter of Jan. 1, 1662, to Cureau de la Chambre, Fermat announced that he had accomplished his proof.[2] Fermat showed that the path of a refracted ray of light was that which takes the least time! (See Figure 2.) The discovery, now known as Fermat's Principle of Least Time, was more than the Cartesians could stand. In fact, it is probably more than most readers can stand—they just don't know it.

To understand why you probably can't stand it, consider the following objections to Fermat's Principle made in May 1662 by Clerselier, an expert in optics and leading spokesman for the Cartesians on this matter[3]:

"1. The principle you take as a basis for your proof, to wit, that nature always acts by the shortest and simplest path, is only a moral principle, not a physical one—it is not *and* can not be *the cause of any effect in nature."*

Does anyone disagree? Clerselier continues:

"This principle is not the cause, because it is not the principle which makes the action, but rather the hidden force and power which reside in each thing, which things are never directed to a given effect by this principle, but rather by the force which results from all the causes that come together into a given action, and by the present disposition of all the bodies on which this force acts."

I argue that there is still nothing for the modern physicist to disagree with. If the phrase "hidden force and power which reside in each thing" sounds a bit strange, then what do you mean by a *force of attraction,* or by *inertia?*

Clerselier, again:

"And [Fermat's] principle can not be the cause, for otherwise we would be attributing knowledge to nature: and here, by nature, we understand only that order and lawfulness in the world, such as it is, which acts without foreknowledge, without choice, but by a necessary determination."

Don't we agree? Nature cannot act

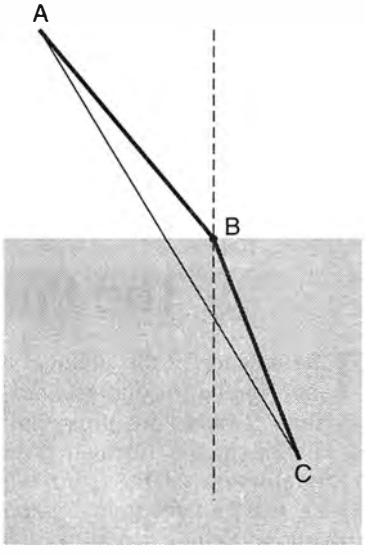


Figure 2
FERMAT'S PRINCIPLE OF LEAST TIME
In 1662, Pierre de Fermat proved that a ray of light passing from a rarer to a denser medium, follows the path which takes the least time. The straight line AC *would not take the least time, because the ray, in this case, would be spending a larger part of its course moving more slowly in the denser medium.*

with foreknowledge. Is not evolution the result of random events, ordered by the survival of the fittest? Back to Clerselier:

"2. This same principle must make nature irresolute, not knowing which way to go when it makes a ray of light pass from a less dense to a more dense medium. For I ask you: if it is true that nature must always act by the shortest and simplest path, and given that the straight line is undoubtedly shorter and simpler than any other, would it not make nature hesitate, (if you wish that it act by this principle), when a ray of light, passing from a point in a rare medium to a point in a dense one, must simultaneously follow both the straight line and the bent one, since if the one proves shorter in time, the other is shorter and simpler in length? Who will decide, and who judge?"

Who indeed?

Intention in Nature

Finally, Clerselier argues:

"3. As it is not time which moves, it cannot be time which determines the motion, and when a body is once moved and set on a certain path, there is no reason to believe that time, greater or lesser, could cause this body to change its path, since time does not act on it and has no power over it. But, as the entire speed and direction of this body depend on its force and the disposition of its force, it is much more natural, and, in my view, much more scientific, to say as Mr. Descartes does, that the speed and direction of this body are altered by the alteration which takes place in the force and the disposition of this force, which are the true causes of its movement, and not to say as you do, that they change by an intention which nature possesses of always taking the path it can pursue most quickly, an intention which it cannot have, since it acts without knowledge, and thus has no effect on this body."

So, if we accept Clerselier's arguments, as almost every scientifically educated person today would have to admit he does, Fermat's Principle of Least Time is an absurdity. And yet it is true, and stands as one of the foundations of all our knowledge of nature. From it came the work of Leibniz and the Bernoullis on the cycloid and the non-algebraic curves, which were the heart of the development of the calculus. Fresnel's developments of the wave theory are based on it, and so everything we know of the electromagnetic spectrum, and so forth.

What then is wrong with your view of nature? We can hardly think of a better argument for the existence of *intention* in nature than that to which Clerselier leads us in his attempt to oppose it. We have been arguing for such a standpoint, the one which is the actual basis of all modern science, which begins with Nicholas of Cusa's great breakthrough in the *De Docta Ignorantia* (On Learned Ignorance), and proceeds through Leonardo, Kepler, and Leibniz, into the work of Gauss and Riemann, reaching unfortunately a temporary dead-end about that point.

But we have had some trouble getting your attention. Perhaps, if you have followed the argument, we can hope for a bit more success here.

—Laurence Hecht

Notes

1. *Oeuvres de Fermat*, Paris, 1891-1922, T. II, p. 354 (cited in C. Carathéodory, "The Beginning of Research in the Calculus of Variations," presented on Aug. 31, 1936 at the meeting of the Mathematical Association of America in Cambridge, Mass., during the tercentenary celebration of Harvard University).
2. *Ibid*, p. 457.
3. *Ibid*, p. 454.

The Political Issue of 'Human Cloning'

The essence of the political issue of "cloning," is underscored by a current series on this subject appearing in the German popular-entertainment daily *Bildzeitung*. There we find featured a reported intention to clone a replica of Adolf Hitler, using material extracted from Hitler's skull. Ironically, this scandalous news item accurately underscores the fact, that the current rash of proposals for cloning do, like much of current trends in U.S. health-care policy, parody the Nazi regime's views on the biology of mankind.

The inhuman views of the Nazis, and those Americans who, back then, shared and praised the Nazis' eugenics policies, are echoed widely today among those susceptible persons who have been duped into admiration for the cult of "molecular biology." What is new, is the revival of the kinds of thinking on eugenics associated with the Nazis then, as is to be seen now in the influence of the science-fiction cults of the "New Economy" cult of "information theory," and "artificial intelligence," today. There has been a recent spillover of those science-fiction cults, into the spread of such wildly reductionist doctrine of molecular biology as the infamous "Bell Curve" racism spilled out of locations such as Harvard University.

The clear and present danger from the spread of this "human cloning" fad, is to be recognized in the mass slaughter of cows and sheep in the United Kingdom and elsewhere. That killing, in conscious and malicious violation of all well-established, successful methods for dealing with the control of the spread of hoof-and-mouth disease, is being explained by some official circles in Britain, as a probable precedent for the application of the same mass-killing policies against human beings, in the case of major epidemics among human populations.

If we look around us, in the world at large today, no honest and intelligent person could deny, that there is, indeed, the smell of Auschwitz in the currently panicked efforts to ram through such wild-eyed assertions of the universal authority of molecular biology, as seeking clearance for human cloning.

—Lyndon H. LaRouche, Jr.
Aug. 10, 2001

Prince Bernhard *Was* A Nazi!

To the Editor:

As a lifelong professional in the nuclear industry, I enjoyed the articles on the revival of the nuclear technology in your Spring 2001 issue ["The New Nuclear Power," p. 49]. However, I take strong offense at your comments on our Prince Bernhard, who—as co-founder of the World Wide Fund for Nature—seems to be very unpopular with your editorial staff.

Especially the description of him on page 69, as "former Nazi Party member Prince Bernhard of the Netherlands" is inflammatory and totally unfounded. Let me inform you that Prince Bernhard was the commander-in-chief of the Dutch Resistance during World War II, and was—and is—highly regarded for his democratic attitude and loyalty to the Netherlands' war veterans. To call him a Nazi is slanderous. To connect his name with whatever folly is undertaken by the WWF in their green ideology, is foolish.

Furthermore, the Dutch royal family itself can hardly be accused of anti-nuclear opinions. It was Prince Bernhard's spouse, Queen Juliana, who—in 1968—brought the first Dutch reactor in Dodewaard to power. In an opening ceremony, she was asked to pull the control rods so that the plant would come to full generator output. She did this so enthusiastically, that the plant almost tripped on overpower, and the unit manager had to interfere with the unheard-of words, "This should be enough, Your Majesty."

The present Crown Prince, Prince Willem-Alexander, did not hide his interest for nuclear technology when he visited our plant recently to be informed on the 1997 plant upgrading project. He went into the reactor building in full protective clothes, with a lot of media interest. It was a big boost for our public relations effort. I am not aware of any USA presidential candidates visiting nuclear power plants!

So, I would be grateful if you correct your comments on our royalty in the upcoming issue of *21st Century.*

Jan Wieman, Nuclear Fuel Cycle Manager, Borssele NPP

Marjorie Mazel Hecht Replies

Our description of Prince Bernhard as a former Nazi Party member is entirely accurate. Although the details of the Prince's history may not be widely known to the younger generation in the Netherlands, they are available to anyone willing to do the historical research. The photocopies shown here (pages 6-7) documenting Prince Bernhard's membership in the Nazi Party, are part of the historical record.

This is not simply a question of an "unfortunate" past. Membership in the Nazi Party then, and the promotion of Malthusian environmentalism and terrorism now, are predicates of the same pro-oligarchical ideology. Both fascism and Malthusian environmentalism view human beings as no better than beasts. For the Nazis, this rejection of the Judeo-Christian tradition, which sees mankind as made in the image of God, was expressed in Hitler's state doctrine of "useless eaters" and the practice of brutal "eugenics" to get rid of them.

The present-day Malthusians may come up with variations on why and how to get rid of the "useless," "over-consuming" human eaters, but the end result is the same: culling the human population by opposing the advanced science and technology that would foster prosperous economies, able to support a growing world population.

Like Hitler, the Malthusian environmentalists don't hide their people hatred. Prince Philip himself has said publicly that he wants to be reincarnated as an AIDS virus to better aid the process of depopulation.

We uncovered the details of the Royal control of environmentalism in the course of a special project to make public the actual *fascist* background of today's anti-nuclear, anti-population environmentalist groups. Anyone concerned with the promotion of science and technology for the betterment of all mankind, needs to know this background, in order to win the fight against the Malthusian forces who want a New Dark Age, with a world population under 1 billion.

Prince Bernhard, along with Prince Philip of Great Britain, founded the World Wildlife Fund or WWF (now called the World Wide Fund for Nature) in October 1961. Its purpose was to fund and popularize their human-removal, animal-"conservation" plans for Africa and developing nations in general. Ten years later, Bernhard and Philip founded the "1001 Club," an elite group of 1001 Malthusians, whose $10,000 initiation fee goes into a trust fund to bankroll the WWF activities.

Prince Bernhard was the first head of the WWF. He was replaced in that capacity by Prince Philip in 1971, after the revelations of his role in the Lockheed bribery scandal forced Bernhard to withdraw from his more public functions.

The murderous activities of the WWF, especially in Africa, and its spawning of eco-terrorism networks are documented in great detail in a 218-page special report published by *Executive Intelligence Review.*[1] Prince Bernhard was intimately involved in the African depopulation plans, personally funding such projects as "Operation Lock."

As for Bernhard's Nazi past, here is a summary from the special report:

"Prince Bernhard first became interested in the Nazis in 1934, during his last year of study at the University of Berlin. He was recruited by a member of the Nazi intelligence services, but first worked openly in the motorized SS. Bernhard went to Paris to work for the firm IG Farben, which pioneered Nazi Economics Minister Hjalmar Schacht's slave labor camp system by building concentration camps to convert coal into synthetic gasoline and rubber. Bernhard's role was to conduct espionage on behalf of the SS. According to the April 5, 1976 issue of *Newsweek,* this role, as part of a special SS intelligence unit in IG Farbenindustrie, had been revealed in testimony at the Nuremberg trials.

"When Bernhard left the SS to marry the future Queen Juliana, he signed his letter of resignation to Adolf Hitler, 'Heil Hitler'! William Hoffman writes in his book *Queen Juliana:* 'Tensions [over the marriage] were not cooled when . . . Adolf Hitler forwarded his own congratulatory message. The newspaper *Het*

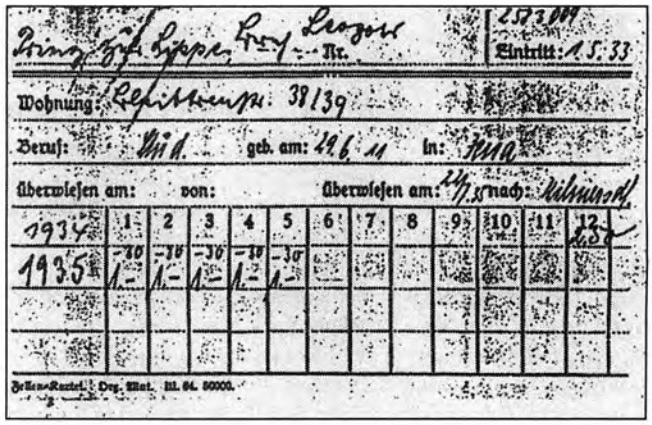
Volk editorialized that "it would be better if the future Queen had found a consort in some democratic country rather than in the Third Reich.'"

It is conceivable that the Prince's view of Hitler changed after Hitler's forces invaded The Netherlands. Nevertheless, Prince Bernhard's anti-population policies and programs as a founder and active leader of the WWF are a matter of public record. Not to acknowledge this history, or be aware of it, makes it impossible for a pronuclear person like yourself to effectively fight for nuclear power—and progress. I suggest that you read the

---

These documents, declassified during the 1990s in the Netherlands and the United States, prove that Prince Bernhard was a member of the National Socialist Workers Party, the NSDAP, or, as it was known for short, the Nazis.

Above: *This is a record of Bernhard's dues payments to the NSDAP. It shows that the Prince ("Prinz zur Lippe, Bernhard Leopold") was born on June 29, 1911, and joined the Nazi Party's Greater Berlin organization on May 1, 1933 ("Eintritt" in the upper right-hand corner). His membership number is 2583009, just above "Eintritt." He left the Nazi party only because he wanted to marry Princess Juliana of the Netherlands, and the Dutch royal family did not want any possibility of scandal.*

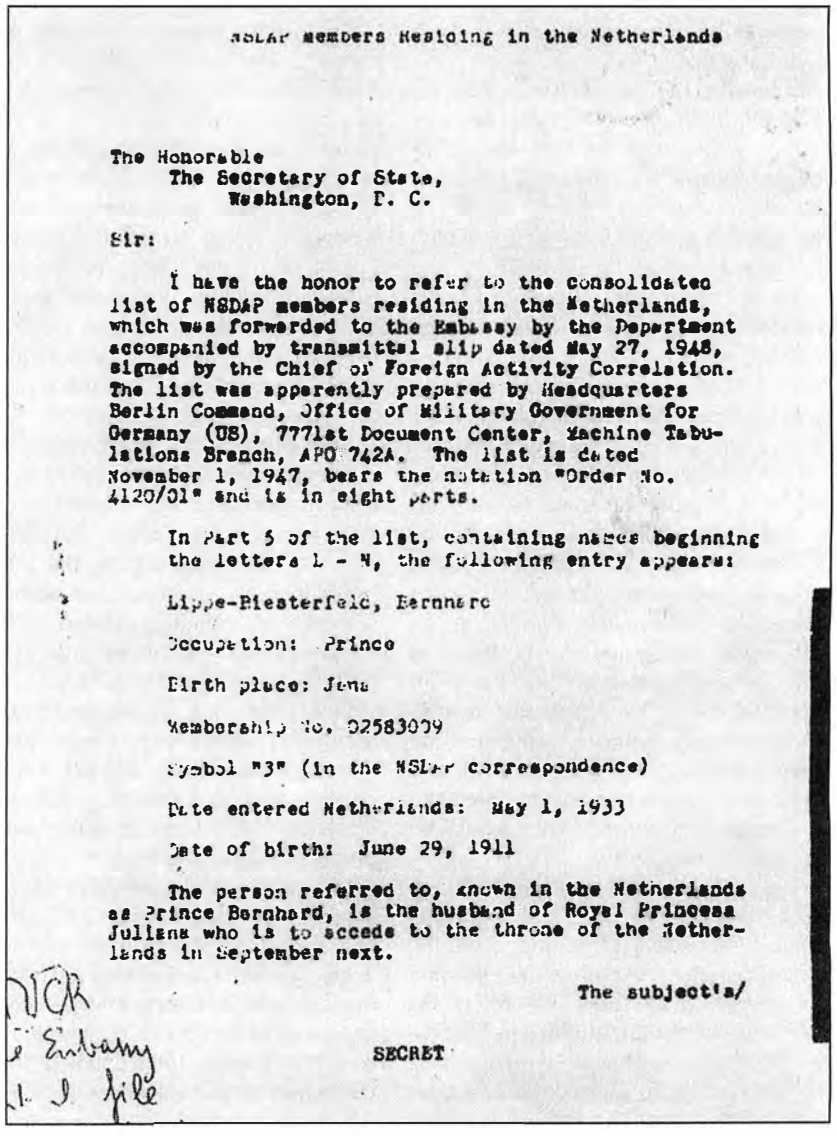


Below: *This is a letter from the U.S. Embassy in The Hague, to the U.S. Secretary of State, confirming Prince Bernhard's membership in the NSDAP, as shown on a list prepared by Headquarters Berlin Command, Office of Military Government for Germany (U.S.) on Nov. 1, 1947.*

Above, page 7: *A list of NSDAP members, including Bernhard as well as other members of his oligarchic family.*

Below, page 7: *A letter dated Aug. 10, 1948, on U.S. Department of State letterhead, to "The Officer in Charge of the American Mission, The Hague . . . concerning the removal of the name of Prince Bernhard from the consolidated list of NSDAP members residing in the Netherlands." The relevant State Department official notes that, "Since Prince Bernhard's name is also included in the consolidated World List, which has been widely distributed through the Government as well as outside the United States, it is felt that at this time it is not practicable to alter the current lists by deleting his name."*

This documentation is part of a Strategic Memorandum on the British monarchy's attacks on Lyndon LaRouche in Brazil and Australia ("Look at What Happened in Brazil," by Lyndon H. LaRouche, Jr.), which appeared in the Feb. 9, 2001 issue of Executive Intelligence Review, *pp. 20-39.*



NSDAP Members Residing in the Netherlands

The Honorable
The Secretary of State,
Washington, D. C.

Sir:

I have the honor to refer to the consolidated list of NSDAP members residing in the Netherlands, which was forwarded to the Embassy by the Department accompanied by transmittal slip dated May 27, 1948, signed by the Chief of Foreign Activity Correlation. The list was apparently prepared by Headquarters Berlin Command, Office of Military Government for Germany (US), 7771st Document Center, Machine Tabulations Branch, APO 742A. The list is dated November 1, 1947, bears the notation "Order No. 4120/01" and is in eight parts.

In Part 5 of the list, containing names beginning the letters L - N, the following entry appears:

Lippe-Biesterfeld, Bernhard

Occupation: Prince

Birth place: Jena

Membership No. 02583009

Symbol "3" (in the NSDAP correspondence)

Date entered Netherlands: May 1, 1933

Date of birth: June 29, 1911

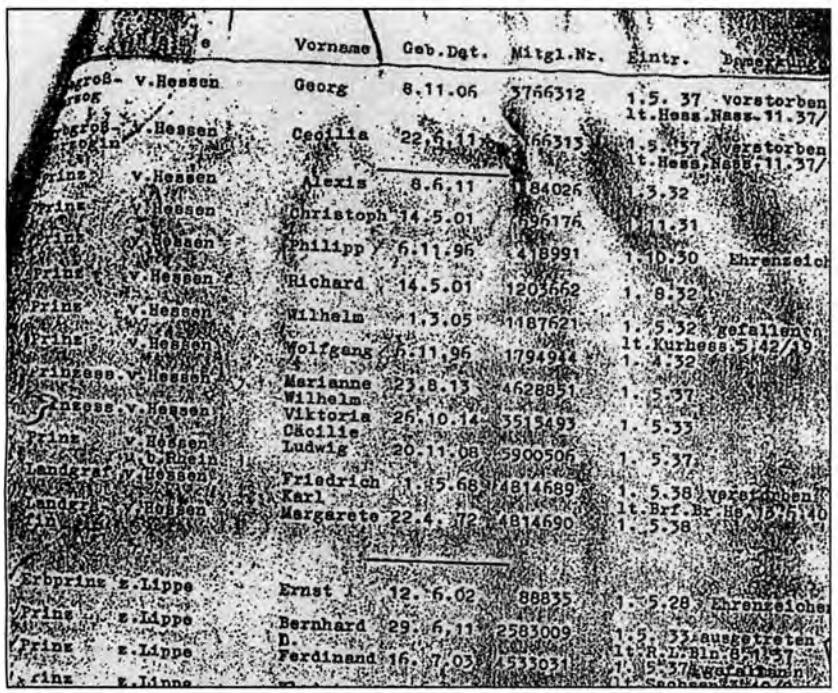
The person referred to, known in the Netherlands as Prince Bernhard, is the husband of Royal Princess Juliana who is to accede to the throne of the Netherlands in September next.

The subject's/

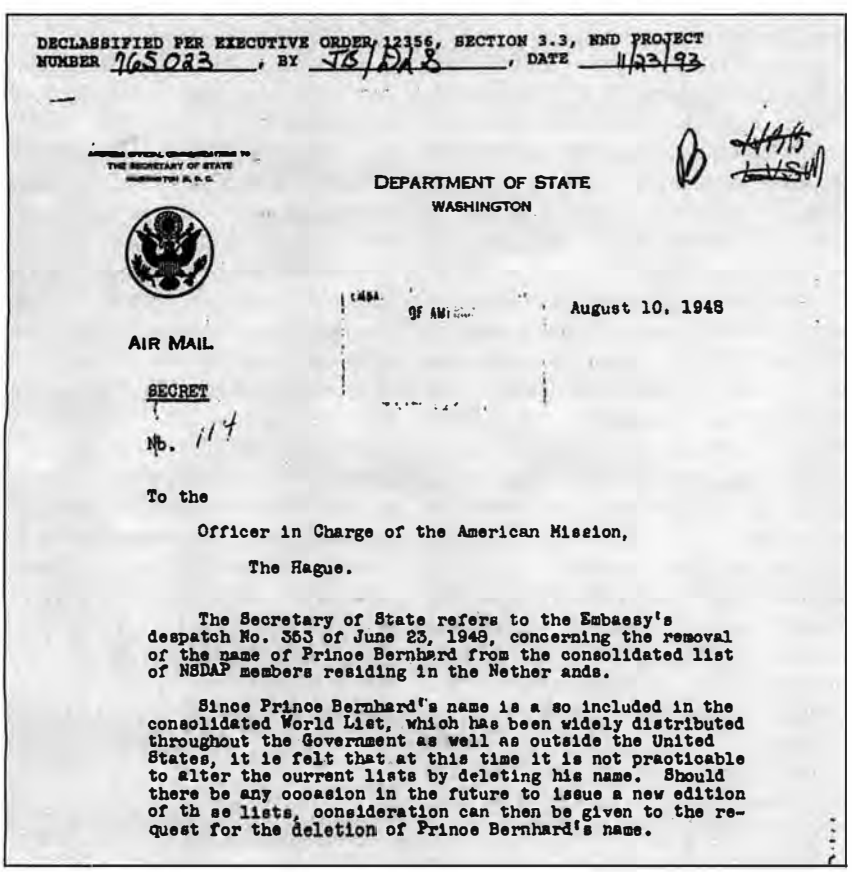
SECRET

interview of Guilherme Camargo, "How Brazil's Nuclear Association Defeated Greenpeace" (*21st Century,* Spring 2001, p. 63) to understand this better.

P.S. Not surprisingly, the only recent U.S. Presidential candidate who visited a nuclear plant was Lyndon H. LaRouche, Jr., for whom the promotion of nuclear energy is a central campaign issue.



	Vorname	Geb.Dat.	Mitgl.Nr.	Eintr.	
v.Hessen	Georg	8.11.06	3766312	1.5.37	vorstorben lt.Hess.Nass.11.37/
v.Hessen	Cecilia	22.1.11	6313	1.5.37	verstorben lt.Hess.Nass.11.37/
v.Hessen	Alexis	8.6.11	1184026	3.32	
v.Hessen	Christoph	14.5.01	6176	11.31	
v.Hessen	Philipp	6.11.96	4 8991	1.10.30	Ehrenzeich
v.Hessen	Richard	14.5.01	1203662	1. 8.32	
v.Hessen	Wilhelm	1.3.05	1187621	1. 5.32	gefallen
v.Hessen	Wolfgang	6.11.96	1794944	1. 4.32	lt.Kurhess.5/42/19
v.Hessen	Marianne	23.8.13	4628851	1. 5.37	
v.Hessen	Wilhelm				
v.Hessen	Viktoria	26.10.14	5513493	1. 5.33	
v.Hessen	Cäcilie				
v.Hessen	Ludwig	20.11.08	5900506	1. 5.37	
b.Rhein	Friedrich	15.6.68	4814689	1. 5.38	verstorben
v.Hessen	Karl				lt.Brf.Br.Hess.5/42/19
v.Hessen	Margarete	22.4.72	4814690	1. 5.38	
z.Lippe	Ernst	12. 6.02	88835	1. 5.28	Ehrenzeiche
z.Lippe	Bernhard	29. 6.11	2583009	1. 5. 33	ausgetreten
z.Lippe	D. Ferdinand	16. 7.03	4533031	1. 5.37	



DECLASSIFIED PER EXECUTIVE ORDER 12356, SECTION 3.3, NND PROJECT NUMBER 765023, BY JB/DAS, DATE 11/23/93

THE SECRETARY OF STATE

DEPARTMENT OF STATE
WASHINGTON

August 10, 1948

AIR MAIL

SECRET

No. 114

To the

Officer in Charge of the American Mission,

The Hague.

The Secretary of State refers to the Embassy's despatch No. 363 of June 23, 1948, concerning the removal of the name of Prince Bernhard from the consolidated list of NSDAP members residing in the Nether ands.

Since Prince Bernhard's name is a so included in the consolidated World List, which has been widely distributed throughout the Government as well as outside the United States, it is felt that at this time it is not practicable to alter the current lists by deleting his name. Should there be any occasion in the future to issue a new edition of th se lists, consideration can then be given to the request for the deletion of Prince Bernhard's name.

Notes

1. This EIR Special Report, "The True Story Behind the Fall of the House of Windsor," was commissioned by Lyndon H. LaRouche, Jr., and published in September 1997, 218 pp.

A Dutch Legal Expert Replies

We asked a legal expert, Mr. J.J.G. Wilgers, from the Netherlands, to respond more specifically on the history of Prince Bernhard. In a Dutch court, Attorney Wilgers has won the right to call the World Wildlife Fund a "criminal organization." He is currently planning to take Prince Bernhard to court in Belgium, for crimes against humanity, concerning his role with the WWF in African genocide. Mr. Wilgers also intends to broaden his suit against the entire leadership of the WWF.

Here is his response:

[Prince] Bernhard von Lippe Biesterfeld did not lead the Resistance. The Resistance, which consisted almost entirely of the left wing of Dutch society at the time, did not allow itself to be led; there was no leadership. Young men of the left showed the most initiative and were not planning to let themselves be led by reactionaries.

It is a question of myth creation. This former Nazi, might have been allowed to take some boys in overalls with a stengun, and call it the Irene-brigade [after one of the Orange princesses], who were supposed to liberate Amsterdam. Queen Wilhelmina begged the Allies for permission to do this.

The Allies kept this remarkable German prince far from the front, and from military activities. The myth about his being a veteran, continuing to this day, is more an indication of the falsification of history and manipulative image-creation. The myth was desired in connection to the postwar domestic situation. Militarily, this Irene-brigade was nonsensical and superfluous. It was further of interest, that a so-called Dutch prince, was allowed to hold the pen in the name of the government during the capitulation in Wageningen.

The real Resistance, has hardly even been mentioned in the news after the war, relative to the inflated veteran story of the [Irene]-brigade. Journalists further developed the myth.

As for the Green ideology, it was drawn slowly from the ideas of eugenics promoter, Julian Huxley. This is a typical

British affair. After the creation of the raw materials protection agency, IUCN (the International Union for the Conservation of Nature and Natural Resources) by the British, which for reasons of quasi-internationalism was established in Switzerland, funds were necessary to satisfy the costs of this agency. Therefore, the World Wildlife Fund was formed.

The British Privy Council was involved in this to a high degree. In order not to reveal to nationalists that this was a British institution, a former German prince was asked to be the President of the Club. That is how this von Lippe Biesterfeld got the opportunity to build his own personal . . . network (the 1001 Club). Under the flag of international interest, the interests of the West were looked after. . . .

Under the flag of international interest, a number of green myths have been spun for the purpose of collecting a lot of money: animal species going extinct, oil wells drying up, climatological disasters, demographic bombs, and so on. . . .

Mr. J.G.G. Wilgers
Yerseke, The Netherlands

On the Ampère-Gauss-Weber Electrodynamics

To the Editor:

Needless to say, I very much enjoyed your editorial on the suppressed electrodynamics of Ampère-Gauss-Weber [Spring 2001]. Science cannot reliably advance without knowledge of the prior history of the subject. With due respect, however, I have to draw your attention to an error in your editorial. Ampère's law does not describe the interaction of "two elements of moving charge."

Ampère defined his current element as an infinitely small (stationary) piece of conductor metal. In our book *Newtonian Electrodynamics* (New Jersey: World Scientific, 1996), we [Peter and Neal Graneau] modernized the concept by describing the Ampèrian current element as an atomic dipole pivoted on the lattice site. Lest there should be any doubt about Ampère's definition, Maxwell expressed it in article 501 of his Treatise as follows:

"It must be carefully remembered, that the mechanical force which urges a conductor carrying a current across the lines of magnetic force, acts, not on the electric current, but on the conductor which carries it."

Wire explosions by Ampère tension would not be possible if the electrodynamic force was exerted on the conduction electrons. These electrons slip through the metal lattice without coupling to the atoms. If this were not so, then an alternating current would rattle the wire to and fro.

I do agree with you that Weber's theory carried the seeds of special relativity. The velocity *v* of charges in Weber's current element became the *v* of the Lorentz force, and Einstein's *v* of the arbitrary observer.

Peter Graneau
Concord, Mass.

Laurence Hecht Replies

You are right that Ampère's Law does not describe the interaction of "two elements of moving charge." The memory of several stimulating telephone conversations last year, in which you underlined this distinction between Ampère's view and Weber's, was on my mind even as I wrote the editorial. Yet I see that even so, I let a misstatement slip in. On this charge, I plead guilty.

Your citation of the quote from Maxwell, however, I think only confuses things. It was doubt over the truth of this very citation which led Edmund H. Hall to make his discovery of what we today call the Hall effect in 1879. His paper of that year in the *American Journal of Mathematics*[1] begins:

"Sometime during the last University year, while I was reading Maxwell's *Electricity and Magnetism* in connection with Professor Rowland's lectures, my attention was particularly attracted by the following passage in Vol. II, p. 144:

[The passage you cited follows, along with several additional sentences from Maxwell].

"This statement seemed to me to be contrary to the most natural supposition in the case considered, taking into account the fact that a wire not bearing a current is in general not affected by a magnet and that a wire bearing a current is affected exactly in proportion to the strength of the current, while the size and, in general, the material of the wire are matters of indifference. . . ."

Hall goes on to say that his professor at Johns Hopkins, Henry A. Rowland, also "doubted the truth of Maxwell's statement and had sometime before made a hasty experiment for the purpose of detecting, if possible, some action of the magnet on the current itself, though without success."

Hall therefore set up an experiment in which a current was passed through a thin gold leaf mounted on a plate of glass. The glass plate was inserted between the poles of an electromagnet so as to cut the "lines of magnetic force" perpendicularly. Measurement with a galvanometer indicated that the current was being deflected in the direction perpendicular to the shortest path of flow of current. The phenomenon, which we now so easily call the Hall effect, thus indicated to Hall that Maxwell was wrong. The current itself is deflected!

Respecting Maxwell, there is no getting around the fact that his famous *Treatise* is a willful attack against both Ampère and the "German school" as he calls it, that for the purest of political motives, science being, then, as always, nothing but politics, if we understand that term in its broadest, and not always derogatory, philosophical sense.

In my view, the problem of what goes on when electricity passes through a wire remains a great enigma. (Hall, you may know, devoted the rest of his life to probing this mystery.) I have nothing but respect for your work on these matters. Yet I cannot buy a formulation such as "These electrons slip through the metal lattice without coupling to the atoms." If the phenomena you cite seem to prove it so, yet it seems there is much else to suppose otherwise. For example, given the snail's pace at which electrons seem to pass though a wire, can we say that an alternating current (or any current) is merely due to the passage of electrons?

I know your thoughts go deep on these matters, deeper than can usefully be probed in a letters column. I, therefore, would invite a longer contribution, for publication, should you be able to find the time for it. Meanwhile, you should find the contribution of Rémi Saumont in the current issue thought-provoking.

Notes

1. E.H. Hall, "On a New Action of the Magnet on Electric Currents," *Amer. J. Math.*, Vol. 2, p. 287 (1879).

More on Weber's Electrodynamics

To the Editor:

. . .Re: Your editorial (Spring 2001):

Fascinating, but I detect a flaw or I don't or can't read English. On page 5 is the *Weber Constant:* "It was found to the product of the velocity of light *in vacuo,* with the square root of 2."

What does that mean? Later: "In electromagnetic units it was equal to the light velocity." (Velocity is totally incorrect. It should be speed.) Got some doubletalk here. What was actually measured was the ratio of the electromagnetic to the electrostatic units that gave the *identical* numerical value that was identical to that for the speed of light. It did not give the speed of light, [which] as a *ratio* is *dimensionless.*

On page 7, first column near bottom: "The Weber critical length has the value [followed by an equation]."

Questions:

- Why was no value for two charges given as proof?

The first term looks like (that square root of 2 bit) like it it is just the speed of light. . . .

The dimensions do not give any remaining value for length. In fact, what are the dimensions for charge. The whole equation's answer?

Further quote: ". . . there is a critical length below which the force of repulsion between two electrical particles is changed to attraction and vice versa!" Very bad and indefinite wording. Which or what two particles? The force of repulsion is only between like charges.

- What happens when the charges are attractive or of opposite signs to start?
- How can they get that close together in the first place? (I am guessing that this length is under an electron's diameter.)
- What do the masses of the particles have to do with it anyway? Gravitational effect is below Planck's Constant, so no gravitational action can take place. Simply, no anti-gravity from any cause.

Lastly, [the internet search engine] Google has nothing on the electrical Weber's Constant and neither do two very old books I have on electricity and magnetism and the "Bible," *Handbook of Chemistry and Physics. . . .*

You have never mentioned [that] I have a book, in your book reviews. . . .

Bert Schreiber
Bellaire, Tex.

Laurence Hecht Replies

You are making two errors of method.

First, you are trying to fit Weber into the box of modern textbook physics. It doesn't work that way. He did the work. He made the discoveries on which Maxwell's fraudulent glosses, and all the modern textbooks are based. Weber's point of view, which follows from Kepler, Leibniz, and Gauss, is entirely different from what is taught today as accepted practice of classroom mathematics. The latter is based on an entirely opposite intellectual tradition, associated with such names as Newton, Euler, Laplace, and Cauchy.

Second, and related, you fail to recognize that science is hypothesis. The character of your quibbles assumes that one can deduce the laws of physics from certain self-evident observations, assuming that one is sharp enough to do so. You seek the errors of others in the deductive process, when the important ones lie, rather, in the underlying ontological, and epistemological assumptions. But a persisting bias to empiricism has caused you to reject these from the get-go. (For more elaboration on this point of epistemology and scientific method, I suggest you study LaRouche's "How to Define a Physical-Economic Collapse: Marat, De Sade, and 'Greenspin,' " in *Executive Intelligence Review,* June 29, 2001.)

Concerning Weber's discoveries in electrodynamics, there is no textbook shortcut to understanding these matters. You must read Weber's writings. Some are in English, and I think you may know some German. Your questions are either answered there, or you will see that they do not have any meaning in the historical context. I presented a summary of the Ampère-Gauss-Weber electrodynamics, including reference to the key original writings, in the Fall 1996 issue of *21st Century.*

Weber's electrodynamics was excised from the curriculum in Germany in the 1880s, after Helmholtz had consolidated his control over the Physics Department at the University of Berlin. The publication of Maxwell's famous *Treatise* did the job in the English-speaking countries, about a decade earlier.

In good friendship, I have to say that it strikes me as ironic that you, one of the orneriest of old iconoclasts I have ever had the pleasure of running into, are just as surprised by the fact that "they" didn't teach you any of this, as any old, run-of-the-mill, establishment-type physicist. But don't get annoyed at me for it. I didn't charge you thousands of dollars for a university education, to claim that you would become educated in physics if you mastered the textbooks I made you buy. In my view, most of them are not worth the BTU-value contained in them.

Concerning the quote you question on page 5, I think your eyes played a trick on you, causing you to drop some lines. The full sentence reads: "It was found to be experimentally equal, in electrodynamic units, to the product of the velocity of light, *in vacuo,* with the square root of 2."

I'm sorry we haven't mentioned your book. We are able to review only a very small portion of those brought to our attention. For interested readers, it is: Bert Schreiber, *Quantum-Quanta, The Theory of the Universe,* (2001) 2 vols., 198 DM (Michaels Verlag, Ammergauer Str. 80, 86971 Germany, Phone: 08861-59018), e-mail: mvv@michaelsverlag.de.

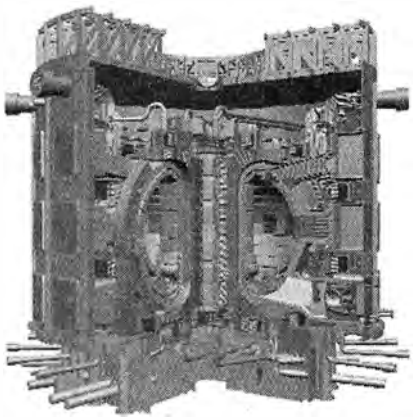
Deregulation and the Invisible Hand

To the Editor:

Regarding the article, "The Fraud of Deregulation (Spring 2000) [by Marsha Freeman], it misses one "slight" point—energy prices have *not* been deregulated by the Democrats in California to allow supply and demand to set prices. (It's called the free market.) They wanted to pander to their electoral base . . . so they only deregulated the supply side, not the demand side. Building socialism is a noble aim, even it if has been proven over and over again not to work. I grew up under communism in Hungary, so I know first hand that political meddling of most kinds only produces misery. You write about a perfect example of it.

Allowing people/companies to sell at whatever price the market bears is the one and only way to make sure there is plenty of everything, including the incentive to produce and/or save. . . . Any price gouging is transitory when the

Continued on page 15



Courtesy of ITER

The July 2001 design for the International Thermonuclear Experimental Reactor, ITER. Canada, France, and Japan are vying for the project site.

"Protect yourself against the false environmentalists!" is the headline of this advertisement for the Portuguese-language book, Green Mafia, *published in Brazil by EIR.*

WILL THE U.S. JOIN THE ITER INTERNATIONAL FUSION PROJECT?

At the "Frontiers in Fusion Research" conference sponsored by Fusion Power Associates in Washington, D.C., Sept. 25, a major question on the agenda was whether the United States will join with Europe, Canada, Japan, and Russia to design and construct the International Thermonuclear Experimental Reactor, or ITER.

Unwilling to spend the $200 million per year that participation in the project would require, the U.S. Congress ended this country's work on ITER during the Clinton Administration. Now, France and Canada have come forward with potential sites for the construction of the tokamak experiment, and Japan will announce its site selection by November. International conference participants indicated their willingness to proceed with ITER without the United States, but it was clear that a major lobbying campaign is under way to have the United States rejoin the program.

The next issue of *21st Century* will include more coverage of this fusion conference.

MONARCH CATERPILLARS ARE *NOT* SENSITIVE TO POLLEN FROM Bt CORN

U.S. Agricultural Research Service (ARS) studies of Bt corn found that monarch caterpillars are not very sensitive to pollen from most types of Bt corn, and that caterpillar exposure to Bt pollen is low. Bt stands for *Bacillus thuringiensis,* a soil bacterium that is engineered into corn as an alternative to conventional insecticides for controlling moth pests. A small, but much publicized study, in 1999 had suggested that monarch caterpillars were injured by eating milkweed leaves that were heavily dusted with Bt corn pollen. This then made headlines with the message "Genetically engineered corn endangers monarch butterflies."

Entomologist Richard L. Hellmich, from the ARS Corn Insects and Crops Genetics Research Unit, in Ames, Iowa, reported that pollen levels had to be "greater than 1,000 grains of pollen per square centimeter before there were any toxic effects in monarch caterpillars, and even greater levels before the effect was significant."

BRAZIL COURT REVOKES ORDER SEIZING *GREEN MAFIA* BOOK

Judge Paulo Mauricio Pereira of the 24th Civilian Court of Rio de Janeiro, on Aug. 29, 2001, revoked his earlier decision to seize copies of the book *Green Mafia: Environmentalism at the Service of World Government* and copies of the magazine *Nuclear Brasil,* in which an advertisement for the book appeared. The reversal came after Lorenzo Carrasco, Brazilian correspondent for *Executive Intelligence Review* and author of the *Green Mafia* book, filed a petition as an aggrieved third party in the World Wide Fund for Nature's legal offensive against the organization of Lyndon H. LaRouche, Jr. in South America, the MSIA (Ibero-American Solidarity Movement).

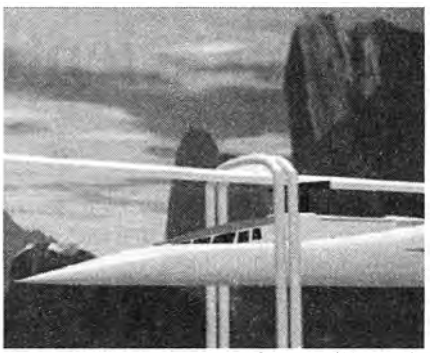
Carrasco, a co-owner of the publishing house that published *Green Mafia,* argued that the book fell outside of the temporary restraining order that the WWF had obtained to prevent the MSIA from publishing or saying anything about the WWF.

Although the books and magazines seized on Aug. 27 were returned to Carrasco, the legal battle, initiated by Prince Philip's WWF against LaRouche's forces in Brazil, continues. The MSIA is still under a temporary restraining order not to say anything about the WWF, and the WWF is pressing for damages in its court case, alleging "slander." The WWF did not present any evidence refuting the truthfulness of what the MSIA said about the WWF, but claimed only that the MSIA had offended its "honor." Meanwhile, the case has become a cause célèbre within the Rio courts.

MAGLEV TRAIN SYSTEM WILL PROVIDE GREATER SECURITY

"As rapidly and as feasible financially, we must begin developing a high speed ground transportation system, for freight and people, operating possibly up to the speed of sound to take the place of commercial aircraft," says Col. Roy D. Vinson (U.S. Army, ret.). Vinson, a hero in Patton's Third Army and later the head of combat training of the South Korean Armed Forces, is the inventor of a unique magnetic levitation system, called Magnetrain, employing hydraulically controlled permanent magnets (see *21st Century,* Winter 2000-2001).

"The fanatical fringe element is not only foreign, but domestic as well," Vinson says in a release issued October 10. "Recent events confirm the fact that disturbed individuals can cause destruction on a limited basis, such as the Greyhound bus tragedy, or a wide-scale basis, such as the Oklahoma bombing of the Federal building. We need to protect ourselves against foreign enemies. But, we also need to protect ourselves from enemies within. Prevention of future catastrophes cannot be totally eliminated, but by rethinking our mass transportation system, future tragedies can be greatly reduced."



Courtesy of Magnetrain

The Magnetrain maglev system, designed by Col. Roy Vinson, uses permanent magnets for levitation, and a patented hydraulic system to maintain an air gap. Here, an artist's conception of the Magnetrain as it enters a station.

'THE WORLD IS GOING TOWARDS A GLACIAL ERA,' SAYS LINDZEN

"The end of the world is not ahead," climate scientist Richard S. Lindzen told the Italian newspaper *Corriere della Sera* June 15, in an interview with Alessandra Farkas. "The world is going towards a glacial era," Lindzen said. "In one century the climate will be different from today, but simply because atmospheric changes are the rule. . . . CO_2 emissions have nothing to do with that. . . . Think to the 'miniglacial era' that brought snow and ice to Europe in the 17th and 18th Century. Or to the Middle Age Optimum, where the word pollution did not exist yet, but Iceland and Greenland were temperate, inhabited areas, where wine grapes were grown. Temperatures, at that time, were between 2° and 5° C higher than today."

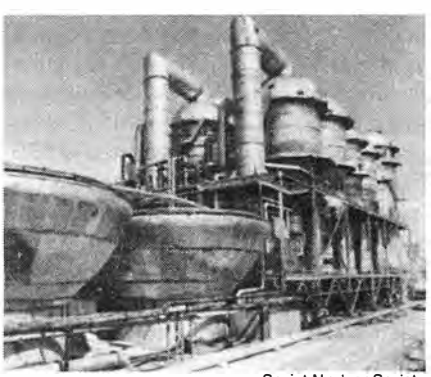
Lindzen, a Professor of Meteorology at the Massachusetts Institute of Technology, was asked whether man can do something "not to worsen things." He replied: "This question goes out of the scientific field and enters the domain of religion. You are asking me whether sacrifices to gods are opportune to improve things. . . . My impression is that Europe, above all, is prey to environmentalist religion and hysteria."

RUSSIA AND INDIA TO SIGN NUCLEAR POWER PLANT DEAL

Russia will build a nuclear power plant in the southern state of Tamil Nadu, India, according to an agreement between the two countries, to be signed in October. Russia will supply the design, 90 percent of the equipment, and 54 percent of the $1.5-to-$2 billion cost, at 4 percent interest. India will pay for the plant in 14 installments, beginning one year after it is commissioned, which is projected to be in 2007. The plant will supply power to four Indian states.

INDONESIA, REPUBLIC OF KOREA SIGN NUCLEAR DESALINATION PACT

Indonesia and the Republic of Korea signed a memorandum of understanding in October to launch a preliminary economic feasibility study for a nuclear desalination project on Madura Island, Indonesia. The study is under the umbrella of the International Atomic Energy Agency's technical cooperation project on desalting seawater, which involves nine other countries. Korea is now working on a co-generating nuclear desalination plant with a 330-megawatt-thermal nuclear reactor, and Argentina, China, India, and the Russian Federation are also developing reactors for desalination. The coupling of nuclear power plants with desalting plants has been studied since the 1960s. Japan has several small-scale nuclear-powered desalination plants to supply freshwater inside nuclear power plants, and the Russians have 16 small plants on nuclear-powered ice-breakers and other nuclear-powered ships. The only industrial-scale nuclear desalination plant is the BN-350 in Kazakhstan.



Soviet Nuclear Society

The nuclear-heated desalination unit of the Shevchenko BN-350 (now called Aktau) in Kazakhstan on the Caspian Sea—the first and only industrial-scale nuclear desalination plant. The BN-350 is a 135-MWe liquid-metal-cooled fast breeder reactor, in operation since 1973.

An Appreciation of the Work of Fusion Scientist Daniel Wells

by Charles B. Stevens

Daniel R. Wells, Ph.D., Professor of Physics Emeritus at the University of Miami (Coral Gables), died on May 28 at age 80. Wells, a pioneer of thermonuclear fusion plasma physics, was a scientific advisor of *21st Century Science & Technology* magazine and a scientific collaborator of Lyndon H. LaRouche.

Born in New York City on May 2, 1921, Dan Wells received his Bachelor's degree in Mechanical Engineering from Cornell University in 1942. He served as a pilot in the U.S. Army Air Corps during the war, and received his Master's degree in Physics from New York University in 1952, and his Ph.D. in Physics under fusion scientist Winston Bostick at the Stevens Institute of Technology in 1963. From 1955 to 1963, Wells was a member of the Plasma Physics Laboratory at Princeton University. He became an Associate Professor of Physics at the University of Miami in 1964, and a full Professor in 1967.

Dan Wells began his work in force-free coils at Princeton in the early 1950s, and made it the subject of his doctoral work. At Winston Bostick's suggestion, he was looking at the strange structures produced when two conical theta pinches were fired at each other. To him, they looked like vortices, of the sort he had seen when testing aircraft in wind tunnels during World War II. He speculated that these were force-free or quasi-force-free structures, because of their relative stability.

The Trisops fusion device, designed by Professor Wells, later used the theta pinch principle to create stable plasma rings, which, when fired at each other, create the high temperature and high density necessary to initiate the fusion of nuclei.

Wells's theory of minimum-energy configurations for magnetic confinement of hot, thermonuclear plasmas became the basis for fusion experiments involving spheromaks, compact tori, and reverse field pinches throughout the world.

Stuart Lewis/EIRNS

Daniel Wells in 1986: "I am of the school that looks for naturally occurring geometries in the plasma to do the job of confinement."

During the 1970s and 1980s, Wells was a scientific advisor to the Fusion Energy Foundation (FEF), along with his former teacher at the Stevens Institute of Technology, the late Winston Bostick, another fusion pioneer and co-founder of the FEF in 1974. The FEF was the publisher of *Fusion* magazine, predecessor to *21st Century,* which reached a circulation of 200,000 at its height.

When the U.S. government withdrew its funding of Professor Wells's experimental work in the early 1980s (ironically, just after he had experimentally demonstated that his fusion device could work), the FEF began its first major experimental project, reviving Dan Wells's fusion experiments. The FEF took up Wells's experiments not only because it offered the most direct route to harnessing the virtually unlimited potentials of cheap, clean and plentiful fusion energy, but also because it promised to be an experimental testbed for a series of revolutionary scientific breakthroughs.

But, in April 1987, the U.S. government put the FEF into "forced bankruptcy," with the intention of shutting down its work and its support for LaRouche and his missile defense policy, which had been publicly adopted by President Ronald Reagan on March 23, 1983, as the Strategic Defense Initiative (SDI).[1] This historically unprecedented action also aborted the FEF's revival of Wells's experiments.

Breakthroughs

The breakthrough aspect of Dr. Wells's work had come to light in a series of FEF scientific seminars in 1985 and 1986. At that time, Wells, at the instigation of LaRouche, made a discovery which LaRouche described at the time as tending "to revolutionize all theoretical physics, including biology."

Briefly: Wells had presented his work on his experimental Trisops fusion engine and the underlying "force-free" plasma theory it was based upon, at an FEF seminar in 1985. During the seminar, LaRouche interjected the question of whether Wells had ever considered the formation of the solar system, the generation of the Keplerian values for those orbits, and the approximation of the Keplerian values given by the famous Titius-Bode relation in terms of his "force-free" plasma theory and experiments.

Professor Wells meekly replied that he had not. (He joked that the University of Miami Department of Physics had limited him in the domain of astronomy to teaching a general course, primarily for the benefit of the Miami football team.) Wells said that he had not had the occasion to reflect upon the questions involved in the formation of the solar system and the Titius-Bode relation, though some of his postgraduate stu-

dents had begun explorations of the implications of force-free plasmas for general relativity.

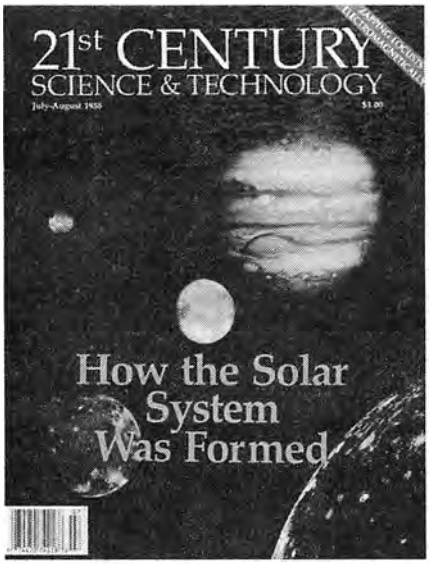
In early 1986, Professor Wells reported to the FEF that he had carried out the required review of the material, and to his great surprise, he was able to account for both the Keplerian values for the planetary orbits and the Titius-Bode approximations, based directly on his "force-free" plasma theory. He presented his results to an FEF seminar in early 1986. (His article on this, "How the Solar System Was Formed," appeared in the July-August 1988 issue of *21st Century.* LaRouche wrote a related memo, "Private Information Concerning the Coming Report on 'Keplerian Orbits' In Local Plasma and Related Events," dated April 11, 1986.)

As LaRouche had forecast, Professor Wells did begin to extend his "discovery" to fundamental physics questions, such as the curvature of space-time, the structure of the "vacuum," the atom, the nucleus, and subatomic particles. But Wells's discovery also sparked another revolutionary scientific discovery—that of Dr. Robert J. Moon's nested Platonic solids model of the atomic nucleus.

Dr. Moon was also a co-founder of the Fusion Energy Foundation, and in 1986 he was the scientific director of the Foundation. Previously, he had been a Professor of Physics at the University of Chicago, where he had been an experimental pioneer during the Manhattan Project of World War II.[2]

Stimulated by the discussion during Dan Wells's 1986 FEF seminar, Dr. Moon reviewed the scientific work of LaRouche. Shortly thereafter, he derived his nested Platonic solids model of the atomic nucleus. Beyond its own revolutionary implications, Dr. Moon's discovery resituated the great scientific work of Ampère, Gauss, Weber, Riemann, and Beltrami—the leading physical science minds of the 19th century. He had long been a champion of their electrodynamics, as opposed to those of Clerk Maxwell and company.

From the standpoint of both Wells's and Moon's discoveries, it was clear that it would be possible to rework the initial discoveries of Johannes Kepler, the founder of modern physical science, in terms of Ampère, Gauss, Weber, Riemann, Beltrami, and LaRouche, unleashing a new scientific renaissance.



Wells's working through of the generation of the Keplerian values for the orbits of the solar system, in terms of his "force-free" plasma theory, was the cover story of the July-August 1988 issue of 21st Century.

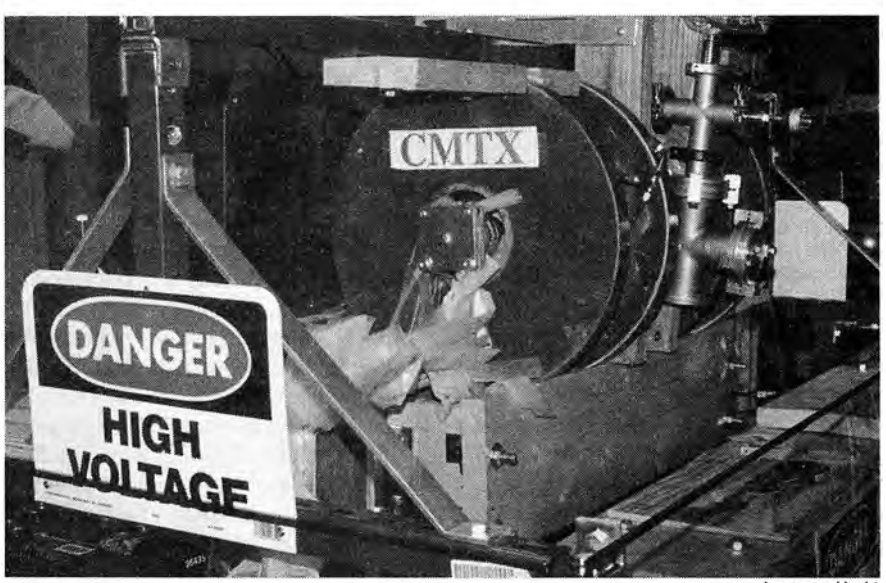
The Busemann Angle

Some inkling of these future developments was first arrived at by this author in 1978, during a laser-matter interaction conference held in Moscow. At that time, I was informed by Professor V.A. Belokogne of Moscow State University of the broader implications of the work of the German aerodynamicist Adolf Busemann. I was already aware of the work of Busemann in developing the modern theory of supersonic flight, and his role as the most creative aerodynamicist of the German jet and rocket programs. After World War II, Busemann was brought to the United States, where he made major contributions to the U.S. efforts along these lines.

At the end of the war, many of Busemann's collaborators and his own papers were captured by the Soviets. It has generally been reported that these also provided fruitful contributions to the Soviet Union's aircraft and rocket programs. What Belokogne reported to me was twofold: First, Busemann's aerodynamic work was primarily based on Bernhard Riemann's discovery and concept of the shock wave. Second, he reported that Busemann had applied Riemann's concept of the shock wave to the possibility of harnessing inertial confinement fusion.

Also, according to Belokogne, this Busemann work provided a critical input to the development of the Soviet hydrogen bomb. This can be seen, for example, in the published work of the Soviet scientist Sedov's pre-1945 and post-1945 work. This 1978 rediscovery of the Riemann shock wave concept also led directly to the LaRouche-Riemann Economic Model.

I was also aware, at that time, that Adolf Busemann's work was the initial spark for Dan Wells's "force-free" plasma theory and fusion experiments. At



Laurence Hecht

A 1999 version of Wells's Trisops conical focus fusion device, currently under investigation at U.S. national laboratories.

Langley, Virginia, in the early 1950s, Busemann had written a short note on force-free plasma structures, probably in connection with his work on hypersonic aircraft. Wells came to know these structures during his wartime flight testing.

Wells went on to apply the work of Eugenio Beltrami to these force-free plasma configurations of Busemann. Beltrami was a leading Italian mathematical physicist and educator in the latter part of the 19th century. He founded the Italian school of aerodynamics, whose theoretical descendants are still at the forefront of the field, many of whom directly collaborated with Adolf Busemann (for example, Tony Ferri). Beltrami was also a leading collaborator of Bernhard Riemann. In fact, Riemann assigned Beltrami to refute the electrodynamics of Clerk Maxwell, as opposed to those of Ampère, Gauss, and Weber.

Wells wrote about the application of Beltrami's work to plasma research in the theoretical journal of the Fusion Energy Foundation, *International Journal of Fusion Energy,* July 1985 (Vol. 3, No. 3).

Reviving Trisops

Until recently, I was involved in a private effort to revive Dan Wells's Trisops fusion experiment. Work on the Trisops approach is now continuing at various U.S. national laboratories—Los Alamos, Livermore, and Sandia—as an application of the development of magnetized target fusion.

I had the great pleasure of knowing Dan and his wife, Mary, for more than a quarter of a century, and of benefitting from his ideas about fusion energy.

We extend our sympathy to his family.

Notes

1. The FEF and two political publications associated with LaRouche, which were also put into forced bankruptcy, brought suit against the government, and two and one-half years later, won its suit and then won again against the government's appeal. Federal bankruptcy judge, Martin V.B. Bostetter, Jr., ruled that the government had acted "in bad faith" and perpetrated a "fraud on the court."
2. For example, during the war, Dr. Moon utilized the cyclotron he built and designed at Chicago to figure out how to procure pure enough graphite to make a nuclear pile work. He then went on, with his close friend and scientific collaborator, James Franck, to oversee the construction and successful operation of the Hanford plutonium breeder reactors. But it was also Franck and Moon who authored and circulated the Concerned Scientists petition against the unnecessary dropping of the atom bombs on Japan, and later Dr. Moon became the first editor of *The Bulletin of the Atomic Scientists.*

Remembering Bob Stevenson, Oceanographer and Friend

by Marjorie Mazel Hecht

Dr. Robert E. Stevenson, one of the world's leading oceanographers and the "father" of space oceanography, died of cancer Aug. 12 in Hawaii, at age 80.

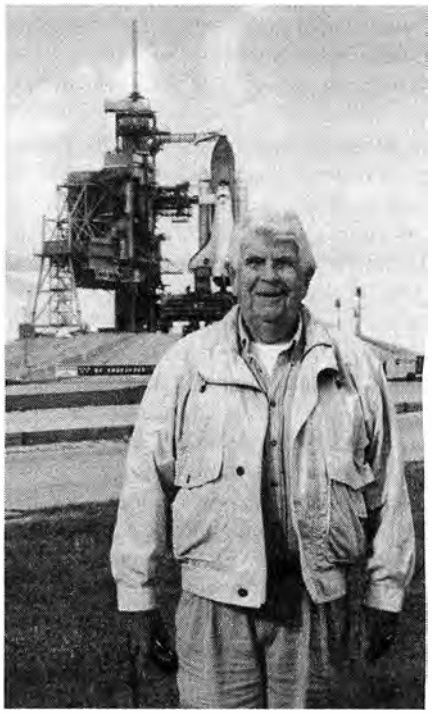
As a scientist and teacher, Bob was a joy. His broad knowledge of the oceans, atmospheric science, and history, combined with his commitment to truth, his wonderful sense of humor, and his willingness to take on colleagues who fell into the politically correct swamp, gained him an enthusiastic following among scientists and laymen alike. He also was not afraid of learning something new, even when it meant giving up a fondly held idea.

Bob was a member of the scientific advisory board of *21st Century Science & Technology* magazine, and took his job seriously, offering ideas and criticism, and writing articles until just before his death.

He was a great educator and raconteur. One could not help but have fun listening to him talk about the historical development of ideas in oceanography—or almost anything else. In the course of his career, he wrote more than 100 scientific articles and several books, including the most widely used textbook on the natural sciences.

After earning a doctorate in oceanography at the University of Southern California in 1954, Bob became a special research oceanographer for the U.S. Office of Naval Research in London. He later taught oceanography at the university level and directed the biological laboratory of the Bureau of Commercial Fisheries from 1965 to 1970. Then he rejoined the Office of Naval Research, as its scientific liaison officer in San Diego, and later as its deputy director, working at Scripps Institute of Oceanography.

The U.S. Navy awarded Bob its highest civilian award, the Meritorious Civilian Services Award, in 1985, for his innovative role in applying space technology to solving problems of the oceans.



Bob at the Kennedy Space Center in December 1998, just before the launch of the Endeavor Space Shuttle.

Fathering Space Oceanography

From the 1960s until his death, Bob worked as a consultant to NASA, instructing astronauts in the observation of the oceans from orbit and revolutionizing what we know about ocean dynamics. He was scheduled to fly on the Space Shuttle in 1984—and would have become, at the time, the oldest space traveller—but he did not, because his wife was seriously ill. His younger colleague, oceanographer Dr. Paul Scully-Power, flew that mission instead, as the first Australian in space.

Scully-Power wrote of his friend and mentor: "Bob was *the* instructor to the Astronaut Corps. He instructed each and every one of them in the greatest of all endeavors of the Corps—looking at mother Earth and understanding what

they saw, and recording that which was new. In this sense, he is singularly responsible for one of the greatest treasure troves of knowledge that we have today of the Earth."

Bob launched his more recent work in training young astronauts head-on against the strong current of popular opinion on global warming, ozone holes, and the like. His 1996 briefing book, for example, was titled "As the World Burns and Glaciers Grow to the Sea."

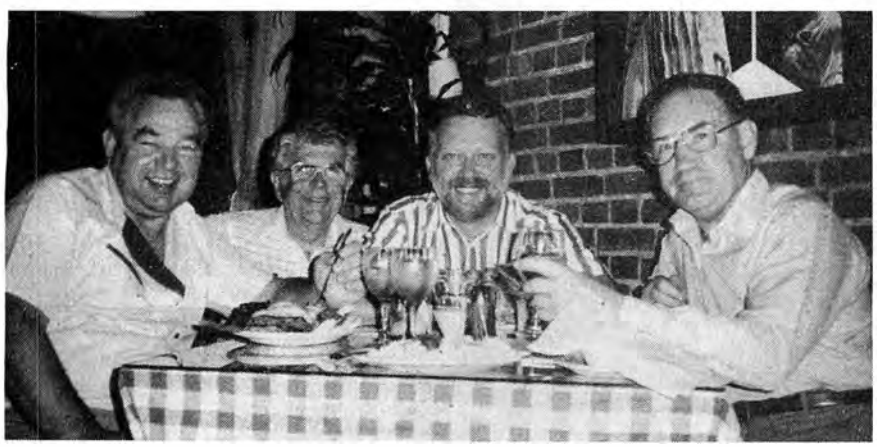
Although Bob retired from the Office of Naval Research in 1988, he continued to train astronauts and to steer oceanographic affairs, serving as the Secretary General of the International Association for the Physical Science of the Oceans from 1987 to 1995. In this capacity, he worked with oceanographers from around the world, and organized two major international scientific conferences as part of the International Union of Geodesy and Geophysics, one in Vienna in 1991, and the other in Honolulu in 1995.

Bob also remained active in the Confederate Air Force, a volunteer group of World War II veterans who refurbished B-17s and other World War II aircraft and took them on air show tours around the United States.

21st Century magazine will publish more of Bob's articles in its coming issues. Recommended reading, for those not familiar with his work, are his article "Spiral Eddies: The Discovery That Changed the Face of the Oceans" (Fall 1998), telling the story of how the Skylab and Shuttle observations revolutionized our knowledge of the oceans; and his account of how climate science was buried by "an avalanche of ideology-based computer models," in "An Oceanographer Looks at the Non-Science of Global Warming" (Winter 1996).

We extend our sympathy to Bob's wife, Jeani, and his two sons, Robert and Michael. We will miss him.

Bob in August 1998, on an airshow tour with the "Sentimental Journey."



An informal session of the International Association for the Physical Science of the Oceans, in Vancouver in 1987. From left: Dr. Georgiey Grechko, Cosmonaut on Soyuz and Salyut; Bob Stevenson; Dr. Paul Scully-Power, then of the Naval Underwater Center in New London; and Dr. Ned A. Ostenso, Director of Oceanography of the U.S. Office of Naval Research.

Letters

Continued from page 9

market is allowed to produce new supplies and competition.

Steve Kingsley,
Ridgewood, N.J.

Marsha Freeman Replies

The writer seems to be unaware of the economic history of this country. State responsibility to ensure that there are adequate, reliable, reasonably priced supplies of electricity is not socialism; it is the principle of promoting the "general welfare," as stated in the Preamble of the U.S. Constitution.

Electricity is not a "commodity," but critical infrastructure, which enables the development of industry and agriculture, similar to transportation systems, and a clean water supply. That is why the industry was regulated by the government, after the Wall Street-controlled abuses of the 1920s.

The dramatic and sudden catastrophic rise in electricity prices charged to utilities and citizens in California over the past year did not arise from an imbalance in supply and demand, or from a lack of competition. It has been amply demonstrated through a look at the facts, that even when demand was low this past winter, power generators and marketers gamed the market to drive up the price, and fleece the population.

In Texas, where there is 20 percent more supply than demand, on the first day of deregulation, day-ahead prices spiked to $1,000 per megawatt-hour.

Forcing people to pay exorbitant prices for electricity will not bring balance to "supply and demand." It will just continue to raise the profit margins of the energy pirates who are manipulating the market, and leave the lower third of the U.S. population little access to the 20th century's greatest contribution to economic prosperity.

Correction

The Astronomy Report, "How I Know Pluto Is a Kuiper Object," Summer 2001, p. 80, misstated the date of discovery of the asteroid Chiron: It was discovered in 1978, not 1970.

Far from being an uninterrupted Dark Age, the Middle Ages was the period when science was reborn in the West, its flower being the cathedral movement. The cathedrals were schools, and their building sites laboratories of invention. The cathedral movement was the prelude to the Renaissance of the 15th and 16th Centuries.

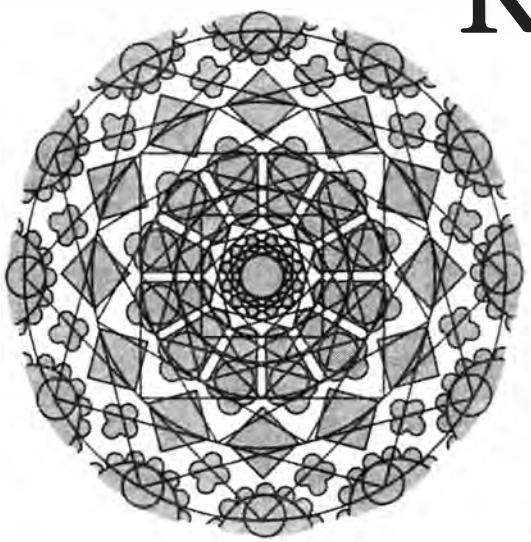
"We are dwarfs on the shoulders of giants. If, indeed, we see more, and farther, than they, it is not that our sight be keener, nor that we be greater, but that we are raised up by them."

—Bernard de Chartres (ca. 1130)

The western facade of Notre-Dame de Chartres in France.

P. Messer

The Scientific Renaissance of The Medieval Cathedrals



by Philippe Messer

A great disaster befell the history of thought in the year 48 B.C.: the Library at Alexandria was burnt to the ground. The soldiers of Julius Caesar, bearing what some might call "the White Man's Burden," simply destroyed 700,000 priceless works of science, the effects of which destruction are felt to this day. Scientific thought in Europe was to be reborn solely through the process of building the 80 or so cathedrals of this continent, between the 12th and 13th Centuries. The cathedrals should not be seen as symbols of prestige, put up by cunning artificers, or by some elite with access to arcane knowledge. They are the fruit of efforts to rediscover what had been forgotten of the Ancients, and to afford the common people access to that storehouse of ideas.

The drive to educate the people, was launched by Saint Colomban (ca. 530-615), and by a handful of Irish Augustinians, who built a network of roughly 150 monasteries on the European continent, between 575 and 725. Among those monasteries, some became a beehive of intellectual life, open to all including those who had no intention of entering religious orders. The Emperor Charlemagne adopted this educational project as his own, and, in 782, appointed Alcuin, a monk from York, to act as his advisor, and to run the Palatine School at Aachen.

Converting pagans by brute force, by rote-learning of dogma, was not Alcuin's way. To convey the meaning of Holy Scripture, Alcuin drew upon forms of knowledge outside of the Scripture: "the degrees of the sciences of grammar and philosophy lead to the peak of evangelical fullness." He wrote to Charlemagne that

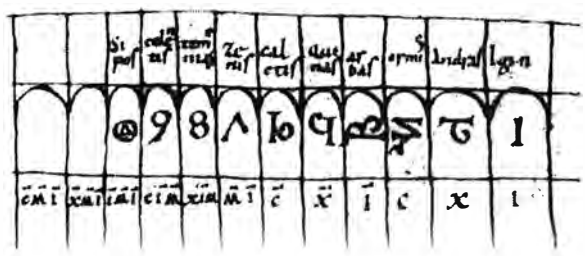
> were many to share your intentions, Franken would be the seat of a new Athens, indeed, a new Athens, finer than the old. For our own, elevated by Christ's teaching, would outstrip all the wisdom of the Academy. The old had but Plato's disciplines to teach with; despite which, shaped by the seven liberal arts, it shines forth yet. Our own shall enjoy the sevenfold fullness of the Spirit, and shall carry far beyond all the dignity of secular wisdom.

These were not words cast upon the winds. In 789, the *Admonitio Generalis* (General Advisory) proclaimed: "Let there be schools to teach the children to read. Let there be in every Bishopric and monastery, the teaching of psalms, notes, singing, arithmetic, grammar. . . ." In 805, guidelines to the *Missi Dominici* stressed the importance given education under Charlemagne: "Readings. Song. Scribes, that they not mar the page. Notaries. Other disciplines. Arithmetic, the art of medicine." The monasteries that had been built up by the Irish Augustinians spearheaded these initiatives, but on the parish level as well, elementary schools were opened, in a vast scheme to educate leaders, both laymen, and churchmen.

In addition to guidelines from the Imperial seat, the Church took major steps. In 789, a Synod laid down that each bishop must set up a school in his jurisdiction; in 813, a Council ordered the opening of schools to teach letters and the Holy Scripture; in 816, another Council arranged the clergy into chapters and defined how each chapter was to run a school. On Charlemagne's death, feudal structures gnawed away at the Empire, but the schools stood firm as power structures dissolved.

Gerbert, the Precursor

In 972, Gerbert was appointed head of the Reims episcopal school. Although he never built a cathedral, he introduced a science hitherto unknown in France, without which the



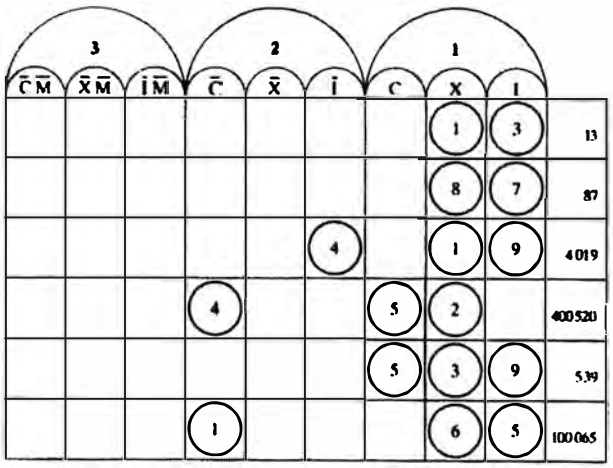


Figure 1
GERBERT'S ABACUS FOR SPEEDING CALCULATION
Above, the Arabic figures used for the apices, including zero. Right, a representation of part of Gerbert's abacus (from Guy Beaujouan, Autour de Gerbert d'Aurillac*). For the zero, the user left the space empty, or set down a blank token.*

Gothic revolution could never have taken place. His drive to form a political elite committed to the common good, rallied allies to the Cathedral Movement. Gerbert was born at Aurillac, educated at Vich in Catalonia, and probably studied at Cordoba, where a library of 400,000 books attracted both Christian and Jewish scholars. What is known is that Gerbert introduced Arab science into France: arithmetic, with Indo-Arabic numbers; astronomy, through the work on the precession of the Equinox; and other studies in physics and optics.

In 970, he was at Rome, where his knowledge of astronomy and mathematics came to the Pope's attention. In that city, he met Otto the First, King of Germany and Italy. Impressed by Gerbert's mind, the King asked the Pope "to keep the youth by him, and to allow him no means to return to his own land." Gerbert did not, however, remain at Rome, but, as we have said, became head of the episcopal school at Reims in 972. There, he broadened the field of knowledge. In Alcuin's day, theology and grammar were the core of the curriculum. Gerbert stressed the liberal arts, believing, as he did, that there was no divide between faith and reason:

> The Godhead hath given men a great gift, when he did grant them Faith, without denying them Science. The just man doth live by Faith, but yet there must be Science joined to it, it being said of fools, that they do lack Science.

This was the conviction he instilled in his many students, some of whom became great men, such as the French King Robert the Pious, and Fulbert, Bishop of Chartres. The many treatises, notably *De Geometrica* and *De Astrolabio,* left by Gerbert or by his disciples, and descriptions left by a student called Richer, give one a glimpse of the depth of his scientific knowledge. Gerbert developed a new type of abacus, which, in Richer's words, "allowed one to divide and multiply a great many numbers so quickly that, given their multitude, one could perform the operations in less time, than one would have needed simply to formulate."

The abacus was a wooden plank, with compartments, in columns corresponding to the units, by tens and by hundreds, each being in an order of units—thousands, millions, and so forth. The Roman abacus used tokens, each of which had a value of a simple unit. Gerbert used tokens, called apices, on each of which one of the nine Arabic numbers was graven (Figure 1). He explained his choice as follows:

> As is well known, the entire series of the multitude of numbers moves forward from a limit which is a point of departure, and this progression goes towards the infinite. In refusing to qualify this infinite multitude by a multitude of simple names, the philosopher has solved the problem in the following manner: he decided that one should define the limit of a basic quantity; names have been defined which are not composite, solely for those numbers which lie within the borders of that quantity.

Gerbert was less successful in introducing the Zero into his calculations-table; accordingly, the place the Zero should have occupied, stood blank.

Beyond his critical contribution to arithmetic, Gerbert compiled, and made known, the foundations of geometry, which he defined as

> the science of measurable proportions, or, the demonstrable dimension which one seeks through propositions which have been developed for the purpose of measurement.

Relying upon the work of Boethius and Pythagoras, his main work in this area was devoted to the problems of angles and triangles. To Gerbert, the various types of angles are not self-evident facts; he shows how they may be created through "circumferent lines" alone. Having once given a general outline, he showed how one may solve the problem of measuring inaccessible objects, the breadth of a river, the depth of a well, or the height of a tower. To solve the latter problem, Gerbert did not use the cast shadow, as Thales had, but rather proposed using a mirror (Figure 2). The astrolabe was also used as a sighting instrument.

To Gerbert, geometry was not simply a tool for solving con-

crete problems, but a method for conceiving of, or grasping, the Universe:

> [F]or those who seek true wisdom, this science is of great value. It is a means most suited to arming the forces of mind and intellect, and to sharpening the wit, and is, moreover, a most delightful discipline, leading one on rationally, to discover a great many true things, which may strike the many as astonishing and most remarkable, as well as to contemplate the extraordinary properties of the nature and power, alongside the ineffable wisdom, of its Creator, who has placed everything in number, dimensions, and weight.

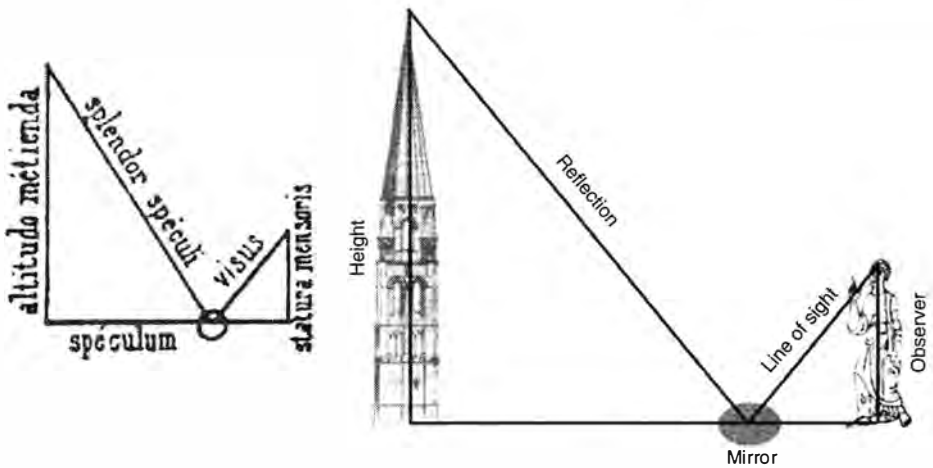


Figure 2
DETERMINATION OF HEIGHTS BY REFLECTION
Gerbert explains: "Having fixed the center of a looking glass, or the center of a water beaker forming a plane surface, the geometer sights from different places, until the apex of the thing to be measured can be seen in the looking glass, or in the middle of the full water beaker. Once he has seen the apex, and carefully measured the distance from the center of the looking glass, as well as the height of observation, this will yield, by a process of comparison, the height of the object to be measured, being a function of the distance at which it lies."

The science which most occupied Gerbert was astronomy. It is to him that we owe reliance on the astrolabe; he had spheres, both full and hollow, built to describe the movement of the planets and of the constellations. Thanks to the astrolabe, a stereographic representation of the world (Figure 3) became possible. This was a disk, on one side of which appeared the terrestrial and heavenly spheres, and on the other, a pivotting rule, to the ends of which were affixed slotted copper plackets. The star was sight-

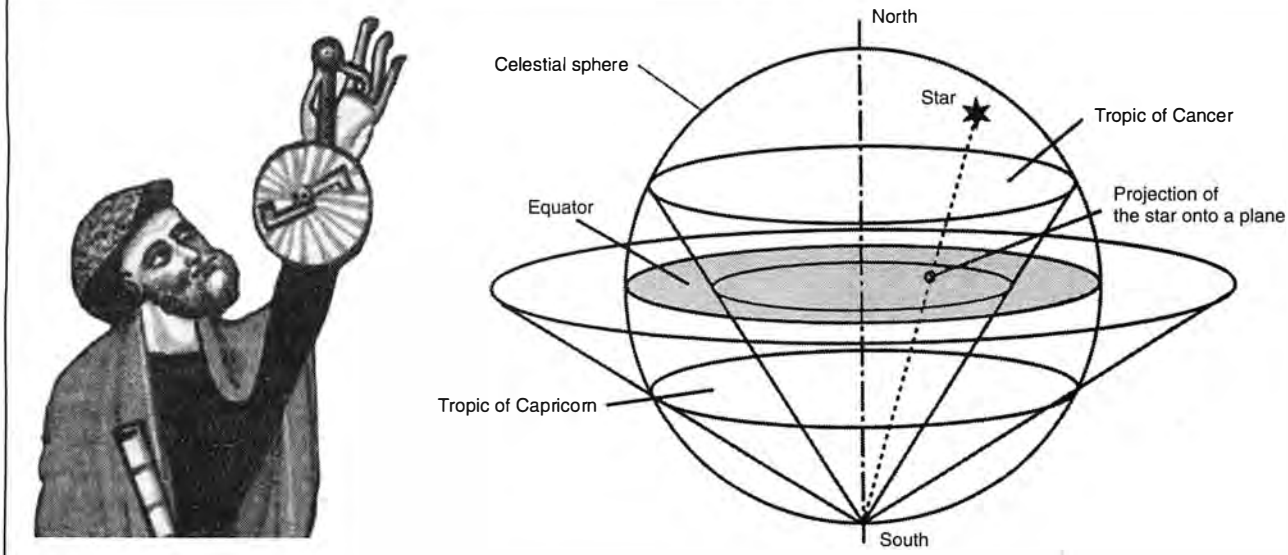


Figure 3
THE ASTROLABE AND STEREOGRAPHIC PROJECTION
The astrolabe was used, in particular, to find the position of the stars, and assess the heavenly coordinates of a star at a given latitude. The astrolabe is based on the method of stereographic projection (diagram at right), which allows one to project the celestial sphere onto a plane surface.

ed through those slots, the height of which was defined by the rule's position, relative to the notches on the disk.

Gerbert also built armillary spheres, to represent the movement of the planets. In that sphere, made up of circles only, the oblique one represented the ecliptic, the parallel ones represent the Equator, the tropics and the polar zones. Richer described the instrument thus: "Within that oblique, he hung the planetary circles, by a most clever artifice. Their revolutions, their respective heights and distances, he did wonderfully explain to the students." Richer further reports on the building of another sphere, whereon the constellations were represented by copper and iron wire. The sphere was cut by a tube to indicate the axis which pointed to the heavenly pole. In Richer's words:

> when one looked at it, the construction represented the Heavens. It was so built, that the stars of all constellations were represented by signs upon the sphere. The construction was a godly one, in that even he who knew nought of the science, could, without a guide, once he had been shown a single one among the constellations, seek out upon the spheres all the others.

Lastly, Gerbert also taught music, a thing theretofore unknown in Gaul. According to Richer, he

> did set out the notes upon the monochord, distinguishing, from their consonance and symphony, tones, semitones, ditones and sharps, and, by rationally ordering the tones and sounds, did make their relations perceptible.

In 980, Gerbert returned to Rome, where he taught this science to Otto the Second, who, in 983, appointed him Abbot of Bobbio, a monastery founded by Saint Colomban and celebrated for its splendid library. The death of Otto, at the hands of the Saracens that same year, forced Gerbert to flee to Reims. Aided by that city's Archbishop, Adalbert, he helped to bring to power Hugh Capet in 987, while supporting the imperilled Otto the Third, then a mere boy, and his mother, Theophania.

Genesis and the Laws of Physics

William of Conches wrote that "what matters, is not that God have done a thing, but to look at that thing, to explain it by reason, to show its purpose and use. God can, to be sure, do any thing, but what matters, is that he have done one, or another, thing. God could, if he would, no doubt make a calf from a tree trunk, as the rustics claim, but has he ever done so?"

"To explain by reason," that is, to understand the cause and nature of things, is what Thierry de Chartres attempted in *De Sex Dierum Operibus* (On the Work of Six Days), where he relied upon Plato's *Timaeus* in interpreting *Genesis*. The reader will find below excerpts of that text, as it gives one a clear notion of the Chartres school method, and how they hypothesized the physical phenomena which govern our universe.

Thierry of Chartres explained what took place on the First Day of Creation, emphasizing that the universe is not a collection of fixed objects, but rather moves:

> "In the beginning, God created the Heavens and the Earth," which means that at the instant time began, "he created" matter. The heavens, being once created, and being of a very lightness, cannot be still, while, containing as they do, all things, could not have moved forward from one to another point: which is why, from the very instant the heavens were created, they did rotate, so as to perfectly accomplish the first rotation in a stretch of time. And that was then called the first "Day."

Thus, Thierry considers circular action to be the essential form of motion of the universe. The Greeks, in developing the isoperimetric theorem, deemed circular action to be the most efficient, that is, the circle which, for a given perimeter, includes the greatest area relative to any other figure. God not only "does not throw dice," but, to the Chartres School, neither does He create the superfluous. Nicholas of Cusa extended that notion with his "minimum-maximum principle," whereby nature performs the greatest amount of work with the least effort, as did Leibniz, who called it the "principle of least action."

Thierry then turned to meteorological phenomena, to describe the process of evaporation and condensation of water:

> The air being illuminated by the power of the higher element, nature has it, that fire, owing to the illumination of the airs, doth heat the third element, being water, and, in so doing, doth raise it above the airs. The nature of heat, is to divide water into tiny droplets, and through motion, to raise those droplets above the airs, as one may see whenever a stewpot give off steam, as do the clouds of the sky, The clouds, like steam, are but a mass of the tiniest droplets raised by the airs, thanks to the power of heat. But if the heat be too strong, that mass will dissolve into pure air; whereas, if the heat's power be but weak, those tiny droplets, one spilling into the next, do become great drops, and then will it rain. Do tiny droplets freeze by the action of wind, then will it snow, while if great drops do freeze, then will it hail.

Having once explained this, rather accurately in point of fact, Thierry presses ahead:

Gerbert became isolated and bogged down in intrigues of various kinds, until, in 997, he received a letter from Otto the Third:

> I am ignorant, my education is but slipshod, do you help me: do you put right what has been ill-done, and show me how I may properly rule this Empire. . . . [E]xplain to me the book of arithmetic you have sent me.

Gerbert thereupon left for Italy, where he wrote for his young pupil, the treatise *Of Reason, and the Use of Reason.*

In 999, Gerbert became Pope under the name of Sylvester II, receiving the ecclesiastical submission of Robert the Pious, King of France, Boleslaus of Poland, and Stephen of Hungary. The dream of Otto the Third and Sylvester II, which was to return to Charlemagne's path, began to take shape, and they pushed so far as to take back Byzantine conquests in southern Italy. Byzantium was not blind to the threat. As early as 809, Charlemagne had attempted, at the Aachen Council, to impose the Filioque principle on the Eastern Empire, Byzantium, which denied that the Holy Spirit proceeds from both the Father *and* the Son. Put in non-theological terms, the Byzantine position amounts to negating man's capacity to grasp, or to consciously master by an act of the will, the laws of the Universe.

And Byzantium did react. In 1001, revolts broke out, organized by the Roman aristocracy, in the course of which both Otto and Sylvester had to flee Rome. Some months later, Otto III died, at the age of 22. Sylvester did return to Rome, but died in 1003. Although one might, at first glance, conclude that their attempt to restore Charlemagne's project had failed, the seeds sown by Gerbert had taken root. His student Fulbert arrived at Chartres in 987, to carry forward the work of his master.

The Chartres Curriculum

On coming to Chartres, Fulbert, who had brought Gerbert's treatises with him, was ready to teach the liberal arts. This bears no relation to "liberal arts" as they are taught in

> . . . the "firmament" are the airs, which, by their very lightness, owing to their nature, do encircle and firmly close about the Earth, collecting it into a spherical shape, and lending it the hardness we may observe: indeed, between the Earth's hardness, and the airs' lightness, there is reciprocal action, whereby, the Earth's hardness doth arise from the compressive nature of the light airs, while the latter's lightness and mobility do take on that nature, through their pressing upon and resting upon the solidity of the Earth.

Here, Thierry has introduced the notion of compressive force, air lending the Earth its spherical shape.

He now turns to the matter of how the continents appeared:

> Indeed, as steam doth rise from a stewpot, the more its watery contents do vanish. If water be spilt over a table, and one then apply heat, those waters will, by effect of heat, shrink, and dry areas appear, as the waters do recede and collect into several parts. So air, between two waters, pressed into action by grandiose heat, did make a third full rotation, and, in so doing, did parcel up the surface of the Earth into islands.

We will end here with what might appear to be an astonishing hypothesis:

> Therefore, all things which are to be seen in the heavens, do take their material principle from water: that is how clouds, lightning, and comets were created. And so it must be, that the stars, insofar as their matter is concerned, are water. . . . Accordingly, the length of the fourth rotation, in which the heavenly bodies did acquire their spherical shape from the waters, suspended in the form of vapor, I say then, that this duration was called the Fourth "Day."

In our day, science has established that the comets do contain ice. In reading the lines above, one cannot but think of the discovery by a team of American astrophysicists, in 1998. They found, in a cloud in the constellation Orion, a gigantic concentration of water vapor. Since that discovery was made, water has proven to be everywhere in space, and to play a key role in the birth of the stars.

—Philippe Messer

Fulbert, Gerbert's student, arrived at Chartres in 987, to carry forward the work of his master, and was appointed Bishop of Chartres in 1006. As this 11th Century illustration shows, Fulbert did not restrict his teaching to the elites, but taught women and children as well.

American universities today. His fame spread, and soon students came from Tours, Besançon, Poitiers, Orleans, and even from Liegeor Cologne to hear him. In 1006, he was appointed Bishop of Chartres by Robert the Pious, and mobilized the support of sovereigns like Stephen of Hungary and Canute of Denmark to finance the building of the cathedrals. However, he did not restrict his teaching to the "elites": an 11th Century obituary shows him teaching men, women, and children. The *Heptateuch,* the treatise on the seven liberal arts prepared by Thierry of Chartres, Abelard's professor, who was Chancellor of Chartres between 1120 and 1153, gives one a distinct picture of what was studied at Chartres. The profane sciences were divided between the *trivium* and the *quadrivium.*

The trivium included:

- Grammar: prose and verse composition, the study of the Latin classics;
- Rhetoric: sacred and profane eloquence;
- Dialectics: Aristotle was the keystone for abstract logic, although stress was laid on Saint Augustine, Boethius, Scotus Erigene, and Denys the Areopagite.

The quadrivium was far more important. As Thierry de Chartres wrote:

> four types there are of reasoning, which lead man to knowledge of the Creator, these being, precisely, the demonstrations of arithmetic, music, geometry, and astronomy.

The quadrivium consisted of:

- Arithmetic and Geometry: the works of Euclid, Pythagoras, Plato and Boethius, as well as more recent treatises like that of Gerbert.
- Music: Fulbert is said to have been a remarkable cantor, and great emphasis was placed on the teaching of music at Chartres. Fulbert, with his friend Sigond, broke with the monotony of Gregorian melodies, and developed polyphonic forms. There sprang up a great school of singing, both sacred and profane, accompanied by the lute, the lyre, or the organ. It had become clear that to express musical ideas, a single musical line, or monody, was no longer enough. Thus, Franconius of Cologne wrote in *De Diaphonia,* that the second musical phrase may free itself from the first, and follow it by notes of varied duration, multiple interventions, and different movements.
- Astronomy: The main authors studied were the Venerable Bede, Abbonius, Denys the Lesser, and certain Arab scientists. Rudolph of Liege, master of the Chartres school, was wont to explain how the astrolabe worked at Mass!

That being said, Fulbert's greatest contribution is not located in the disciplines he taught, but rather how he taught. It was he who placed the Chartres school squarely in the Platonic mainstream. Plato he considered the greatest of all ancient thinkers, and indeed, Fulbert himself was called "venerable Socrates" by his students. He thus locates knowledge, not in the world of sense perception, but in that of ideas. Knowledge does not mean making an inventory of the objects the Universe holds, and classifying them, as Aristotle would do, but rather coming up with hypotheses on the principles underpinning the Universe. Plato does, of course, acknowledge that the senses are of use to grasp the Universe, but he warns against them, as "neither do we hear, nor do we see, exactly," and if one wishes to get to the essence of things "that is, what things are in themselves," this can be done through reason alone.

Thierry de Chartres distinguished the various faculties of the soul in the following way: "Thus, the soul lies level with the beast, when it is but a captive to sensation and imagination. When it places itself at reason's beck and call, it is peculiar to man. When it rises to the level of ideas, to a discipline, it becomes something higher than man, as it relies on itself alone. And finally, when it attempts to soar to the very limit of its capacity, to the simple, unifying whole, and brings thought up to intelligibility, then it relies upon itself, above itself, and becomes a God."

The followers of the Chartres school rejected the notion that man blindly follow superstition, opinion, or tradition. Their principle was that "man was made in God's image," and that one should rejoice in that divine quality, and encourage it. That quality is not a sort of particular gift which God attributed to each individual. It is not a magical "force," summoned up by invoking it. Neither is there a recipe to follow, with the various ingredients of knowledge. One does not become a musician, scientist, or engineer because God so predestined us from the cradle. Were that so, man would have no dignity, following, as it were, a blind destiny; he would be an automaton, animated by an inaccessible spring wound up by God.

The Chartres school proclaimed the sovereignty of the individual. It considered that man in God's image is creative. That creativity does not, however, flow from an innate gift in some special area, but rather in the capacity of all men to grasp the

Universe's laws, and transform the world in which he lives on that basis. The harmony of the Universe is no longer a thing for passive contemplation. Thierry de Chartres wrote that "[God,] in ordering that which was disorderly, has made himself visible even to those who have but scarce knowledge," thus showing himself a student of Plato's *Timaeus,* where we read:

> God invented, and gave us sight, in order that contemplation of the revolutions of intelligence in the Heavens lead us to apply them to the revolutions in our thoughts, which, though disorderly, are yet related to the imperturbable revolutions of the Heavens.

Thus we are not a mere "item" in Creation, among so many others. Man holds a special place, described by Honorius of Autun as follows:

> . . . even had all angels remained in the heavens, man, and the succeeding generations, would nonetheless have been created. For this world was made for man, and by world, I mean the heavens and the Earth, and all which is contained in the Universe.

Reason versus Materialism and Obscurantism

The concept of placing man in the center of Creation did not meet with unanimous approval, even within the Church. Two currents were fiercely opposed to Chartres's humanism. The first was Aristotelianism. Although Aristotle was studied from the standpoint of formal logic, his worldview was rejected by the Chartres school. Fulbert took part in a theological controversy with Berenger of Tours, on the question of Christ's real presence in the Eucharist. The problem which Berenger's thinking represented went far beyond the framework of a polemic on a doctrinal item. Berenger claimed to be defending reason, man being made in the image of God, but his approach was materialist. According to Berenger, the sole means to knowledge, is through sensory experience:

> There is, only what one sees, and what one touches, and one sees but the substance which is co-natural with the accident. . . . [A]ll reality is individual, none is universal: for the senses, the supreme court of all existence, do perceive but the particular. The universal, subject of the idea, thus does not exist, has no reality: it is no more than a concept, or, if you will, a name.

To Berenger, man is a creature incapable of discovering a universal principle, whereas the entire thrust of the Chartres school was precisely to make the laws of the Universe intelligible, and to affirm that one can indeed discover things which one can neither see, nor smell, nor touch.

The other hostile current was led by Bernard de Clairvaux, the leader of the Cistercian order, and by his friend William of Saint Thierry. These figures were notorious as well, for having led the attacks on Abelard, despite opposition by the then-Bishop of Chartres.

Unlike the Irish or Chartres monks, Saint Bernard despised the world. He wrote:

> We, however, who no longer belong to the world, we have left behind for Christ's sake, the beauty of the world, and we know that the duty of a monk is not to teach, but to weep.

Indeed, what was the purpose of teaching, since, he said,

> begotten in sin, sinners, we beget sinners; born debtors, we beget debtors; born corrupt, we beget the corrupt; born slaves, we beget slaves. As soon as we enter this world, whilst we live here, and when we leave it are we wounded; from sole to crown, nothing is whole in us.

Man is but a sinner, according to Bernard, and the only escape, is through penitence. Saint Bernard was also wary of reason, as he deemed it a source of pride.

A very early ecologist, Bernard exhorted men to desert the cities, the Parisian to leave his town, "as they would find more in the forests, than in books." William of Saint Thierry reported that Saint Bernard "thought the best was to be got by meditating and praying in the forests and the fields, and in so doing, to take no master, save the oak and the beech." To pray in the forest was mystical ecstasy through mortification and penitence. Man's relation to the divine order was not intelligible, but rather matter for inexplicable perception, as Bernard de Clairvaux himself said:

> Often did the [Logos] enter into me, and oft did I fail to note that it had come, and I recall its presence. And when I had foreknowledge that it would enter, yet never did I have the sensation thereof, nor when it left. How did it come to enter my soul? Whither did it go on leaving?

William of Saint Thierry went so far as to denounce the Chartres school, which, he said, explains the creation of the first man "not through God, but through nature, spirits, and stars."

William of Conches, the master of the Chartres school, retorted:

> As they are ignorant of the forces of nature, they wish us to remain bound to their ignorance, reject our right to investigate, and would have us live like bumpkins, in belief without intelligence.

Understanding, teaching, explaining—such were the tasks of the cathedral builders. By examining the cathedrals closely, the whole of scientific endeavor of the day will become more apparent to us.

A Challenge to the Laws of Gravity

In 1122, Suger became Abbot of Saint Denis. Having launched, with Abelard's support, a reform of the Abbey, in 1140 he began to build the abbey of Saint Denis, in a style which was pejoratively to be referred to as "gothic," that is, barbarous, by some Italian artists of the Renaissance. By giving the impetus to this scientific and technical revolution,

Suger may be called the key figure in the cathedral movement. He was in a position to act because at the time, he was one of the most powerful men in the kingdom, advisor to Louis VI the Stout, and then to Louis VII; in 1147, during the Second Crusade, he was Regent.

It would be absurd to believe that Suger ever intended to launch a new architectural fashion. To Suger, a church, no matter its style, was not an object, but the visible aspect of an idea. He wrote, concerning the new abbey,

> Through proper composition, the admirable power of a single, supreme reason, causes the disparity between the human and the divine to vanish. And what would appear to be in conflict, owing to its lesser origin, and the contrariety of its nature, is joined by the simple, luminous concordance of a higher, well-tempered harmony.

The manner whereby the building causes "the disparity between the human and the divine to vanish," is by reflecting, in its ornament, composition, and so forth, the harmonious order of the Universe. The builders of the Romanesque churches took the same approach; there can be no doubt but that it was from among those builders that the "Gothic breakthrough" came, lending the idea still greater force.

What, then, did the revolution involve? The builders were faced with an intractable difficulty: weight! As the historian Jean Favier wrote:

> [T]he arch and the vault press downwards upon the walls. Were one to allow the vault so to proceed, the springs would splay, and the wall collapse. Paradoxical as this may be, still more weight was added. The heavier the vault, the thicker the walls. . . . [E]xternal buttresses were used to counter the thrust. It holds, but one can't see a thing. . . .

And the larger the building, the more massive it had to be (Figure 4). As we have seen above, there is nothing superfluous in nature; were they to succeed in putting up larger buildings, architects had to study the operation of nature through force and thrust. Tricks had been thought up to get round some of the difficulties, for example, by using a fluted vault, allowing for somewhat lighter walls, and larger windows. Others developed the broken arch, removing the central part of the traditional arch, strengthening the vault in so doing, since, with the Roman arch, it would tend to collapse. In 1100, in England, intersecting ribs were invented: two diagonal arches were placed under the ribbed vault, crossing at the keystone. The latter technique is nevertheless somewhat unsatisfactory, as it adds weight to the vault. All sorts of technical procedures were thus tried out, but gravity was as obstinate as ever.

The revolution finally happened when the *principle of construction was changed*. Gothic architecture is not just tacking on technical features such as the ogival vault, flying buttress, or broken arches, all of which were known to the Romans. The new principle of construction involved having the vault take over the function of the diagonal rib or ogive, and vice versa. The ogive's function was to stiffen the vault and oppose thrust;

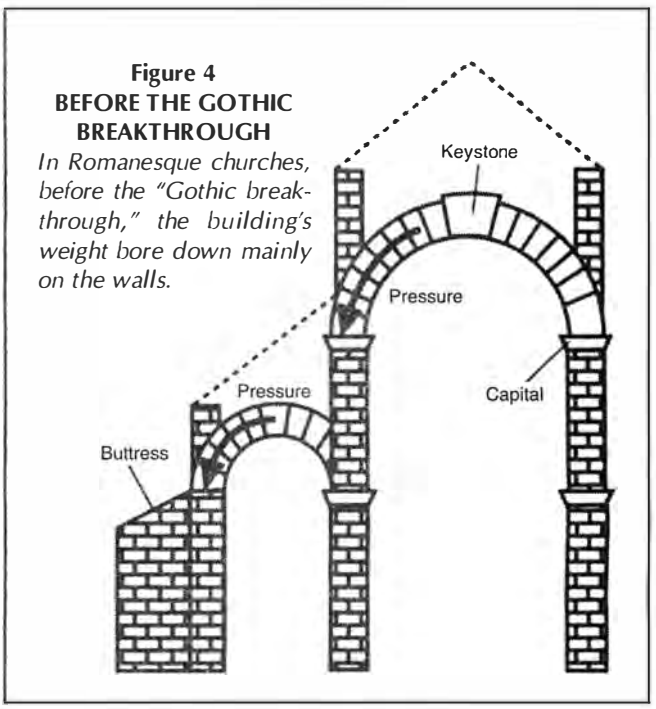


Figure 4
BEFORE THE GOTHIC BREAKTHROUGH
In Romanesque churches, before the "Gothic breakthrough," the building's weight bore down mainly on the walls.

by thus reducing each of the vault's compartments to a mere stone veil, the building's weight, and thus the risk of collapse, were lessened. The builders dared to design a building for which the main support was no longer the vaults and the walls! Thrust was directed to the four points of support, where the diagonal arches of the intersecting ribs ended, rather than onto the walls, into which openings could then be made, to create a flood of light. The architects had succeeded in putting up buildings that, though lighter, were larger. Lastly, an effective vault structure was needed. The early four-part vault had proven unstable, whenever a larger nave was called for; as for the six-part vault, though stronger, its thrust was unevenly distributed. The final outcome was the uneven quadrilateral, a rectangular bay (Figure 5).

The remaining problem was that of the gigantic thrust applied by the weight of the vaults, and by the roof onto the pillars. Rather than build supporting walls either side, the architects chose to consolidate through outside pillars (buttresses and abutment piers), weighted by pinnacles, which supported the flying buttresses. The latter were built stiff enough to bear the thrust, but yet flexible enough, as struts, to act as a buffer to downward stresses (Figure 6).

It should be emphasized, however, that there were reasons other than the purely technical, for the use of the Gothic vault, which greatly contributes to the idea of elevation that springs to mind as soon as one enters such a church. A roman arch, or a cupola, leaves a "finite" impression, of being somehow walled within a half-cylinder or semi-spherical shape. Whereas, with the broken arch and intersecting ribs, one finds oneself between four parallel pillars which meet above our head at the keystone: the parallels meet at the vanishing point (Figure 7). Although painting and drawing had, at the time, lost all notion of perspective, that science appears not only in the overall design of the cathedral building, but in the Rose win-

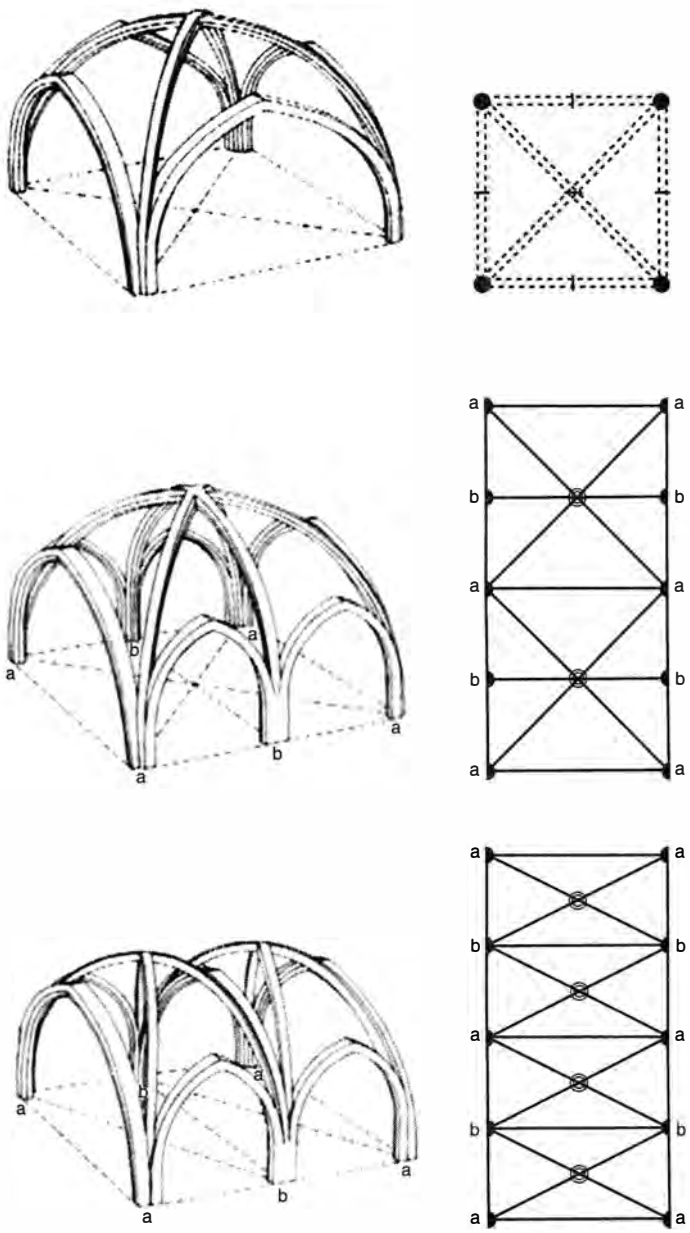


Figure 5
TECHNIQUES FOR LESSENING THE WEIGHT BORNE BY WALLS
To lessen the weight borne by the walls, architects decided to direct thrust onto certain weight-bearing areas. Above, the four-part vault; center, the six-part vault (points a *bear the most weight). Below, the "lopsided" quadrilateral vault, where all points* a *and* b *bear the same weight.*

Source: Sketches by Olivier Leneveu, in *L'univers de Chartres*

dows, which are the projection of a cone onto a plane, all the elements of which point towards the center.

This breakthrough made it possible to transform what might have been massive, overpowering buildings, into light-filled spaces. Light became one of the main "materials" of the cathedrals, but not a mystical sort of light which exercises a magical force over the spirit. One of the day's most widely read documents, Denys the Areopagite's *Heavenly Hierarchy,* gives one a better understanding of what this light meant to the builders of the day:

> All creatures, whether visible or invisible, are a light, flowing from the Father of light. . . . This stone, this block of wood, is a light to me . . . as I observe that it is good, and beautiful; that it is, in accordance with its own rules of proportion; that it differs in genus and species from other genera and species . . . that it cannot be in breach of its own order; that it seeks its place, according to its own specific gravity. In observing such things . . . they become light for me, that is, they fill me with light. For I then wonder whence came the properties of stone. . . . And thus, guided by reason, am I led through all things, to that cause of all things, which gives them place and order, number, species and genus, goodness, beauty, and essence, as well as all other gifts and qualities.

Light is the internal principle which organizes things. We will now try to make this principle of the cathedral visible.

The Cathedral As Mirror of the Universe

A scientist may be a formalist through and through, but he will find it hard not to be moved by the beauty of the Universe. Once he has uncovered its coherence, its harmony, which appears in the infinitely large and the infinitely small, he cannot but feel joy and beauty. The reason that cathedrals too give us the feeling of joy and beauty, is that, in their depths, they reflect an underlying principle of composition which is coherent with the harmony of the Universe. In this way, the cathedral does not imitate nature, the Rose Windows do not look exactly like a Rose. The Rose Windows are beautiful, because they *really* do represent a principle of nature. The point is not to try to weasel out some magical, golden number, or start sketching all manner of geometrical forms. To do so, would distract us from the essential, because what we are looking for is neither a number, nor a shape. Neither do numerology or symbolism have any relevance here, as their only purpose is to decode some conventional object. Symbolists, will for example, tend to go on the assumption that the architects assimilated, arbitrarily, a particular number or geometrical figure to various elements in nature, which is why one finds this number, or that figure, in a cathedral. The truth is that there are no esoteric secrets in cathedrals, and one need not be an initiate to grasp its *principle of composition.*

A clue has been supplied thanks to the work of Roland

Figure 6
CHARTRES' FLYING BUTTRESSES
The small arches within the flying buttresses act as braces against downward thrust. Here, a photo of the flying buttresses and buttresses on the north side of Notre-Dame de Chartres.

Bechmann, who has examined the notebooks of Villard de Honnecourt. The latter's drawings represent standing men, on whom one and the same outline are superimposed (Figure 8). Bechmann writes:

> the rectangle appears to be composed, very precisely, of two rectangles formed on the square and the diagonal, the diagonal of which is equal to three times the small side (because $3^2 = (2\sqrt{2})^2 + 1^2$). . . .

What is interesting, is that this type of proportion appears to have been used for the blueprint of certain cathedrals, such as Reims, Bourges, Troyes, or Tours (Figure 9).

Another clue is supplied by correspondence between two of Fulbert's contemporaries, both masters of the Chartres school, Rudolph of Liege and Ragimbald of Cologne. They had posed the problem of doubling the square's area. Although they did not know Plato's dialogue *Meno*, they came to the conclusion that the only solution to the problem was geometrical, rather than arithmetic. If one takes the diagonal of a square, which becomes the side of another square, the latter's surface will be twice that of the first square (Figure 10). On raising one's eyes to the light of Chartres's Rose Windows, "guided by reason" one discovers the "rules of proportion" based upon doubling the square: the circles inscribed within various nested squares, give the location of the cathedral's three Rose windows (Figure 11). The same configuration appears in the blueprint for the cathedral (Figure 12).

The builders were thus particularly interested in the relation between the square and its diagonal. Why ? Noteworthy is the fact that the square's diagonal is incommensurable with its side. Nicholas of Cusa was to show that polygons were incommensurable with the circle; similarly, the cathedral's designers had understood that for different species, there are different forms of ordering or organization. From an arithmetical standpoint, the square's diagonal is incomprehensible. In geometry, it becomes perfectly intelligible and usable. According to the architects of the day, the nature of the

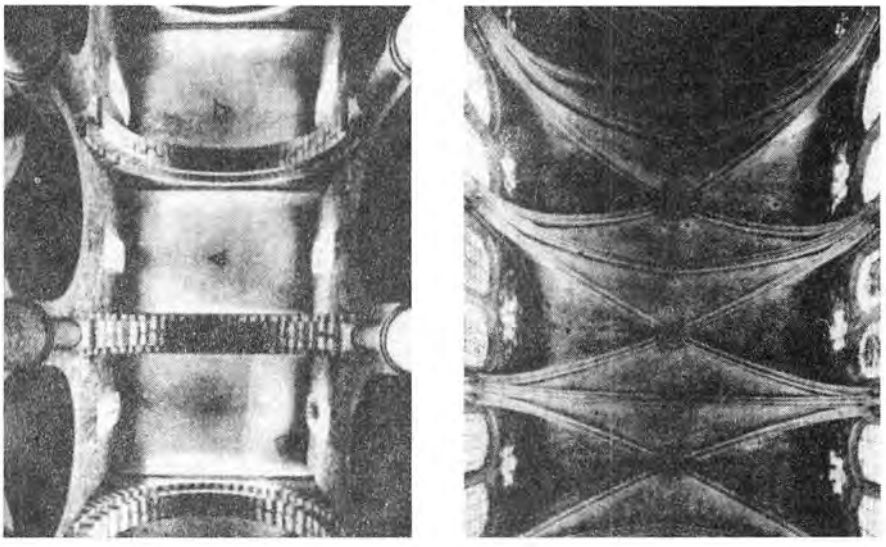


Figure 7
COMPARISON OF STRAIGHT TO DIAGONAL (OGIVAL) VAULTS
On the left, the vaults of Saint Philibert at Tournus. On the right, the ogival vaults at Chartres. A deeper sense of perspective is gained through ogival vaults, as well as a more acute sense of elevation and weightlessness.

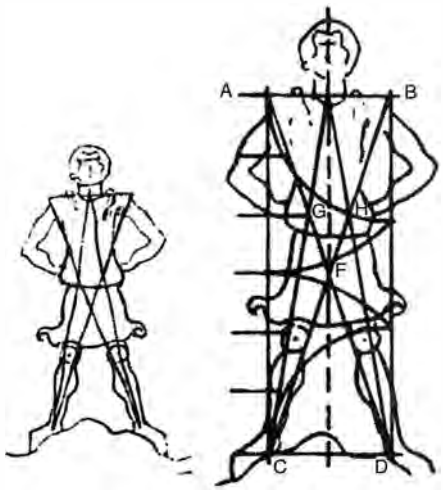


Figure 8
ORIGINAL SKETCH BY A MEDIEVAL ARCHITECT
Original sketch by the medieval architect Villard de Honnecourt of a standing man. The scholar Roland Bechmann has found that the figure can be analyzed into two rectangles, the diagonal of which is equal to three times the short side.

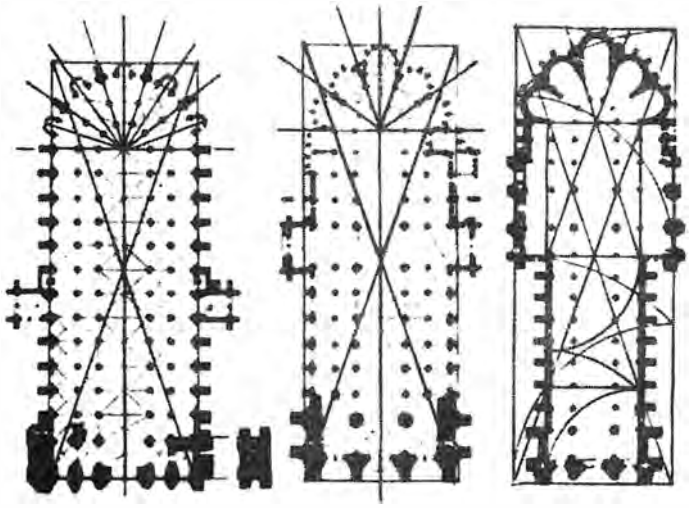


Figure 9
CATHEDRAL PLANS CORRESPOND TO DE HONNECOURT'S 'STANDING MAN'
The plans for the cathedrals at Bourges, Troyes, and Reims. They correspond to the "Standing Man" proportion.

Universe could only be understood through geometry, a domain superior to arithmetic.

One might add that the geometrical progression of various squares in the Rose Windows, is congruent, coherent, with the ordering one finds whether in a flower, or in a far-off galaxy (Figure 13). Kepler was to go further in describing this "harmony of the universe." Recent efforts, by Jonathan Tennenbaum and Lothar Komp, have confirmed Kepler's work, by showing the role of self-similar spiral conic action, both in the well-tempered system in music, and in the the solar system's organization. Lest all these spirals make the head spin, let it be said here that one should simply see them as the signature of a higher ordering. The Rose Windows are not fixed objects, trapped within two dimensions; rather, they reflect a *living principle*.

Impact of This Scientific Renaissance

In *De Sex Dierum Operibus* (On the Work of Six Days), Thierry of Chartres explained that

> the causes of the reality of the world are four in number: the efficient cause, that is God; the formal cause, that is God's wisdom; the final cause, that is his Goodness; the material cause, that is the four elements.

Man having been created in God's Image, and himself being possessed of that creative quality, he must come to know the laws of the Universe (God's wisdom) to intervene into the Universe (the four elements), and improve the world in which he lives (Goodness). These various elements cannot be dissociated.

Cathedral-building, the product of art and of science, flows from that thought. The technological challenge that represent-

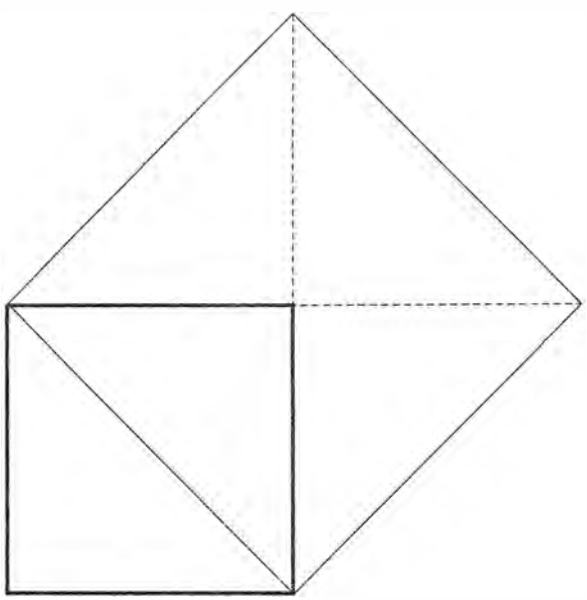


Figure 10
THE FAMOUS PROBLEM OF DOUBLING THE SQUARE
By turning the diagonal of the small square into the side of a second square, one obtains a square that is double the area of the first. This can be proven geometrically, because the small square contains two identical right-angled triangles, while the large square contains four such triangles.

ed, called both for a better grasp of the laws of nature, and for more educated men, more food, a greater amount of energy, better tools, such that all the species of progress which emerged from these building sites, had an impact on the economy as a whole. How cathedral-building became the key factor in European demographic growth and urbanization, between the 11th and 14th Century, is thus more readily grasped.

"Intellectuals" of the cathedral schools, never forgot that time exists only relative to man's intervention into his environment, and the improvements he can effect there. This concern is often reflected in the building's stained glass windows and sculptures. The 12 months of the year are represented by the 12 constellations (the 12 Zodiac signs), alternating with human activity which corresponds to the time of year. One

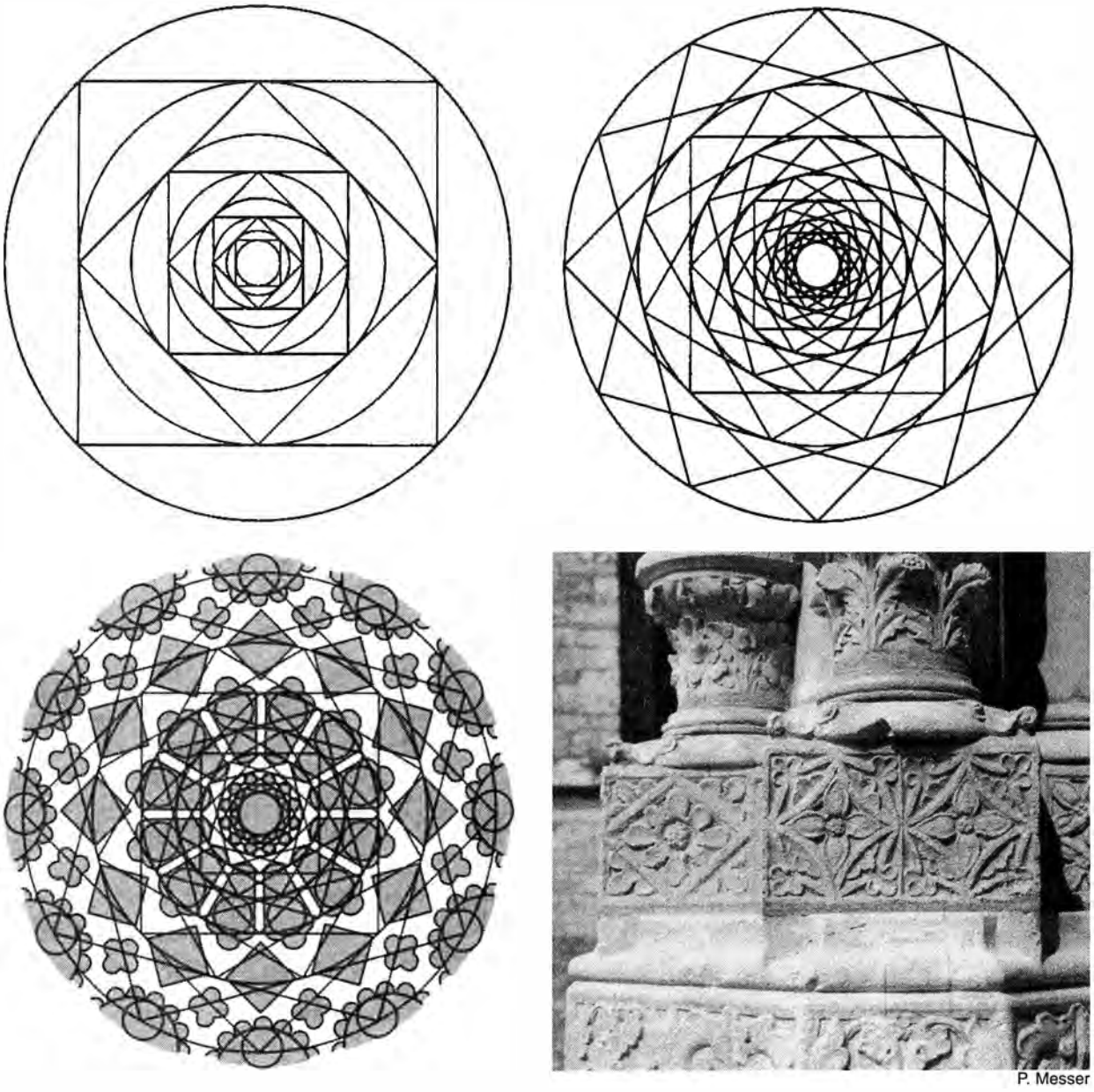


Figure 11
THE ROSE WINDOW AT CHARTRES DOUBLES THE SQUARE

The geometrical principle underlying the three Rose Windows at Chartres, shown in the diagrams here, is simply the doubling of the square's area. This figure represents the North Rose. The photo of the base of pillars from the northern porch of the Chartres cathedral also shows the use of the doubling of the square.

Plainly, cathedrals are no more mysterious or esoteric, than those invisible laws a scientist seeks to discover in the physical universe.

finds the Fish (March) and a vintner cutting his vines, the Goat (April) and a man grasping branches of a tree covered with flowers and leaves, the Bull (May) and a hunter with his falcon, the Twins (June) and a peasant with a sickle cutting grass, Cancer (July) and a harvester, and so forth.

The Cathedral Movement was a true "Great Project," seen from an economic and scientific standpoint, and can properly be compared to the Apollo Program. The building sites were research laboratories, where new tools were developed for construction or work in the fields, for example. The reason is that building the cathedrals meant mechanizing the means of production, as both the quality, and the quantity, of what was produced, outstripped whatever had been known theretofore. The workforce had to be freed from extreme labor-intensive forms of work, to more skilled tasks. The introduction of the cam shaft enabled circular motion to be transformed into reciprocal motion, so as to crush grain, full cloth, saw wood, crush ore, drive iron-mill bellows and smithy-hammers, all with unprecedented ease. Mechanizing smithies led to stronger, more accurate, tools, produced in greater number. Through these advances, ever more houses could be built in stone, and ever more land cleared.

Above all, the central importance of the

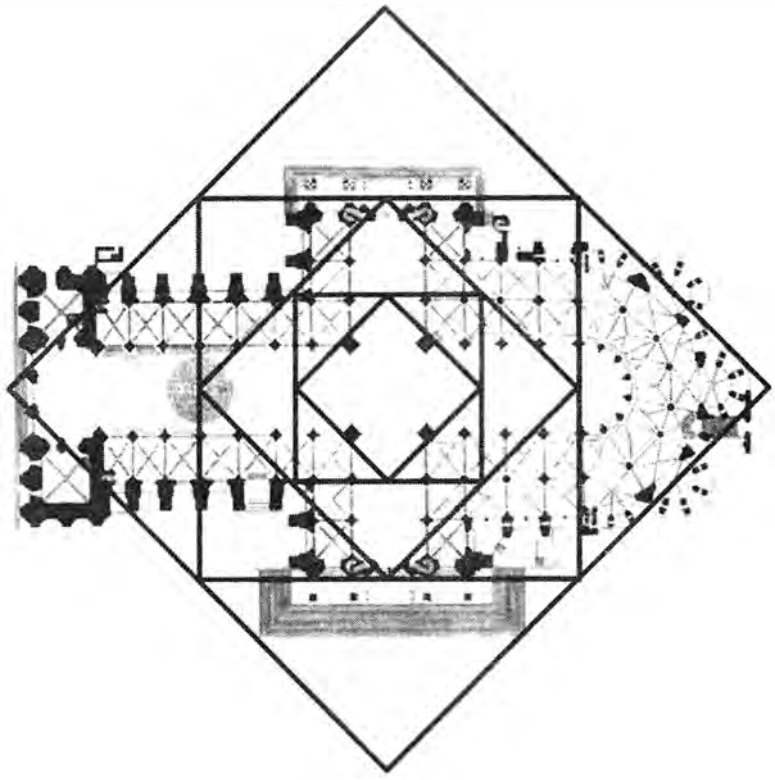
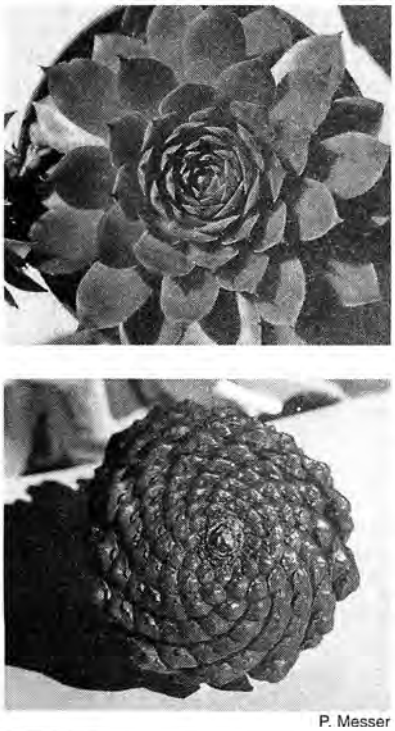


Figure 12
THE SQUARE-DOUBLING PRINCIPLE IN THE PLAN OF CHARTRES
The geometric principle of the doubling of the square recurs in the blueprint for the cathedral.



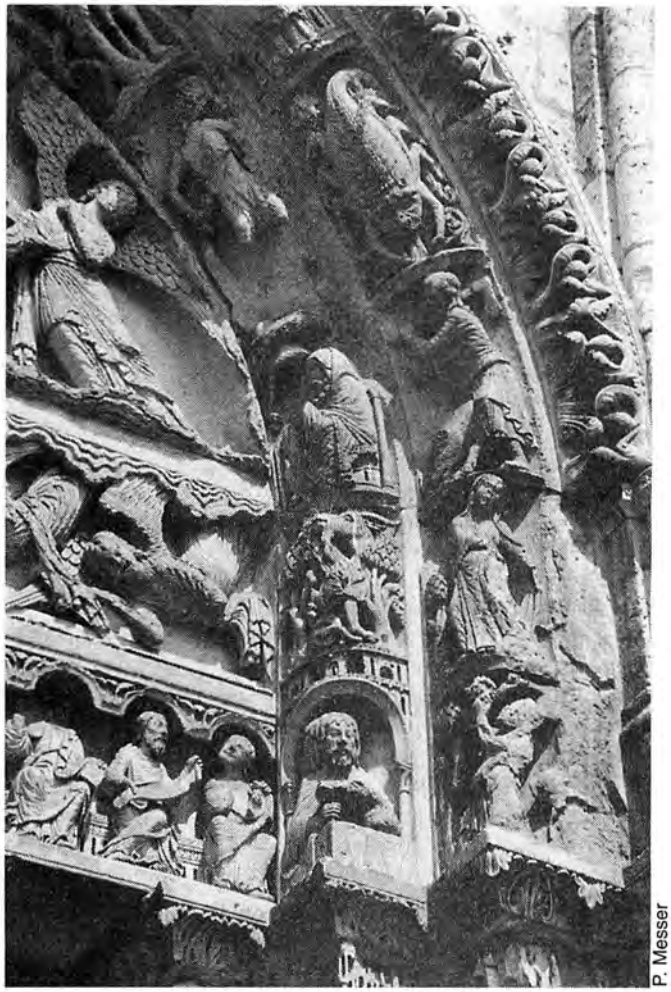
P. Messer

Spiral galaxy in Ursa Major courtesy of Hale Observatories

Figure 13
THE GEOMETRIC GROWTH PRINCIPLE IN NATURE
The principle of geometric growth was not arbitrarily chosen. It is coherent with both the growth of a flower or a pine cone, and that of a far-off galaxy.

P. Messer

Sculpture from the arch on the northern side of the Chartres cathedral, depicting Genesis, with God creating the plants, animals, and Man.



P. Messer

Sculpture at the main entrance to the Cathedral of Chartres portrays labor corresponding to the months of the year, alternating with the signs of the Zodiac.

cathedral movement, lies in the will to end the unjust feudal system. In an epoch where men were, in their vast majority, handled as though they were kine, the cathedral became the most visible, irrefutable statement of Man's creative power, of his divine spark. Suger's idea of doing away with "the divide between the human, and the Divine," challenged the feudal order.

In the Middle Ages, nations were a heteronomous scattering of counties, duchies, and shifting fiefdoms, while authority was splintered among countless autarchical plotlets. Over each such plotlet, a master enjoyed hereditary power on all things, and all beings. The sole unifying factor was the feudal order, which had society arranged into relatively hermetic and fixed orders of knights and noblemen, peasants and Clerics.

At the top of the pecking order were the latifundists, the lords who fed off other men's work. Each such lord could order, compel, and punish, at will. He owned the means of production, the kine, the ground itself, and the men upon it. His main activities were hunting and war, which brought him wealth, raked up by pillaging and ransom. Existence revolved around the fortress and its lord's caprice; he, in his great goodness, undertook to watch over his chattels of every kind.

At the bottom were the peasants, by far the most numerous class. Most were serfs, that is, they were not freemen: they could not dispose of their own goods, could not petition the Courts, could not move about freely. Their life depended on their lord's grace and favor, whether marriage (impossible without permission), or inheritance. On death, all, or part, of a serf's worldly goods reverted to the lord. The serfs were crushed under various forms of taxes and statute labor such as the corvée; the lot of so-called freemen was little better. In short, the serf was a tool at his lord's beck and call. And, as one cannot serve two masters, serfs were strictly excluded from religious orders.

The feudal order's champion, within the Church itself, was Saint Bernard, himself offspring of a feudal lord. It was he who introduced the knightly spirit into the Cistercian Order. As a scion of the military aristocracy, the feudal order was perfect in his eyes, having been brought forth by God. (Not only did Saint Bernard preach the Second Crusade from Vezelay in 1146; he undertook to set up, as he put it, "a new knighthood, God's Knighthood"—the order of the Temple. To Saint Bernard, once a knight had

agreed to renounce earthly delights, chivalry's other principles could stand as they were.) It never struck him as anything but normal that knights should hold sway over their fellow men, a rather free-and-easy interpretation of the heavenly hierarchy.

As a religious community, the Abbey of Citeaux was the perfect embodiment of the feudal social order, divided, as it was, into two classes, the choir monks, and the converts. The choir monks were men of the class of lords, knights, and clerics. They had book learning, and thus, although they did some manual labour, it was they who took part in the liturgical celebrations. The converts were taken from the lower ranks of the peasantry, rustics, meant to remain so.

The two classes were clearly defined, and kept apart. Georges Duby, the historian and admirer of Saint Bernard, described the converts' universe as follows:

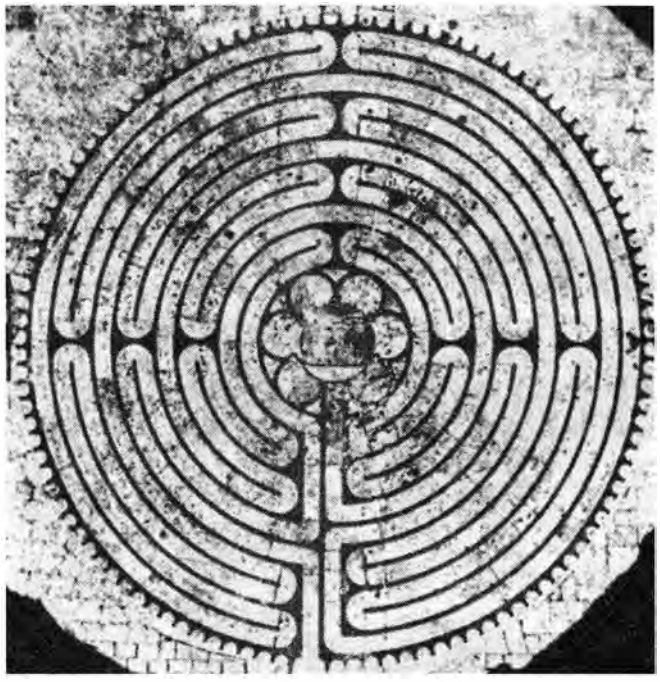
> The converts were quartered off on their own; they had their own dormitory, their own refectory near the cellars, where they swallowed their pittance. Their quarters were isolated from those of the choir monks by windowless walls. They would thread down a blind narrow path to the Church, where they clustered, a silent, black and smelly group, more so than the celebrants united in prayer by their song. The converts were inferiors. They were told, in the name of humility and charity, to delight in their condition, and to be grateful for the coarse victuals they were fed on.

One might add that the local population would, more often than not, suffer from the establishment of a Cistercian Monastery, since, to respect the monks' need for isolation, entire villages were cleared. Lastly, because man, according to Bernard, cannot do good, the best he can do is repent, in the hope that God will forgive his sins. Anything likely to distract man from that course is to be discarded. For example, Bernard demanded such austerity from his surroundings, that he forbad the decorating of churches, or other monastic buildings, with sculpture or painting, and he also forbad stained glass windows, as, he claimed, "when one looks at them, one often neglects the usefulness of proper meditation, and the discipline of religious seriousness."

How revolutionary were Suger's concepts can be better understood against such a background. His primary role was to unify the country, by placing power back into the royal domain. He brought into line many feudal lords, only rarely by force. Finally, he promoted city-building, at the cathedral sites, and also set up new cities, free from feudal power. It was Suger who created the city of Vaucresson, where 60 or so families were settled, protected by a Charter, which stated:

> all those who wish to reside in a new city, named Vaucresson, which we have built, shall receive one and-a-quarter acres land, for twelve quit-rent deniers, free of all taxes and humiliating charges.

Here we find in embryo, the idea of a State responsible for the common good, and idea which, along with the scientific and technical knowledge we have spoken of, was not to vanish entirely. In 1439, at the Council of Florence, the foundations were laid for the Renaissance; one of the Council's key figures, Nicholas of Cusa, wrote a work entitled *De Docta Ignorantia* (On Learned Ignorance) the following year, much of which is based upon Thierry of Chartres's work. In many ways, *De Docta Ignorantia* marks the beginning of modern science. The networks of Nicholas of Cusa included individuals like Jacques Coeur, who founded the modern nation state in France with Louis XI.

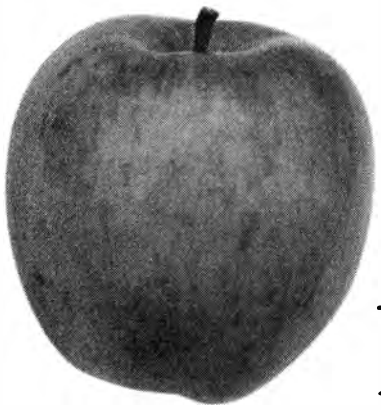


The "labyrinth" pattern carved in the floor of the Cathedral at Chartres is 12.85 meters in circumference.

The Path of Knowledge

There is on the floor of the Chartres Cathedral a labyrinth, the location of which is not haphazard. The distance between the labyrinth and the great portal, is the same as the height between the great portal, and the Rose Window. The labyrinth is of precisely the same size as the Rose Window; it is thus, clearly, the projection of the Rose Window onto the floor. Bearing in mind the principle of the Rose Window, as we described it above, one can imagine that the path the labyrinth follows to its center, represents the path taken by our own thoughts. As you will note, there is but one path to the center—to call it a labyrinth, is in fact, misleading. But the path is long. It is the lengthiest possible, because it covers the circle's entire surface. If you patiently tread the path, you will find yourself at times very near the aim, until the path winds off again. Does the same not apply to man's life? If we act without betraying the voice of Reason, we will assuredly reach the center without hindrance. There is no shortcut. No cut-and-dried solution will speed us to our haven.

Philippe Messer is the Editorial Director of the French-language Fusion *magazine. He is also involved in a campaign to secure ballot status in the French presidential election for Jacques Cheminade, a collaborator of American statesman Lyndon H. LaRouche. His article first appeared in the September-October 2000 issue of* Fusion *magazine, and was translated into English by Katherine Kanter.*



The Paradoxes Of Moving Electricity

by Rémi Saumont

Quantum theory can still not explain some elementary facts about the behavior of electrons in a wire or a condenser. The author, a retired senior researcher and expert in electronics, poses a few of the paradoxes involved.

Judging by the amount of interest expressed, the subject of gravitation seems to concern the educated public more than the physicists themselves, who appear to have given up any hope of discovering facts which would lead to mastery of the subject. The physicists' attitude is shaped by the reductionist doctrines prevailing in science today, which desire to explain everything from laws of the infinitely small, such as in quantum mechanics. The last scientist of renown to resist this incursion was Einstein, but unfortunately his geometrical theory of gravitation was only a phenonomenological description and did not lead to any application.

In fact, humanity has gained control over nature through the application of electromagnetism, while the existence of "electrogravitation" has remained, until recent years, rather hypothetical. However, a number of experimental facts now permit us to envisage its reality, and it would seem that the circulation of electric currents in condensed matter, under particular conditions involving microscopic breaks in symmetry, can produce genuine gravitational effects.

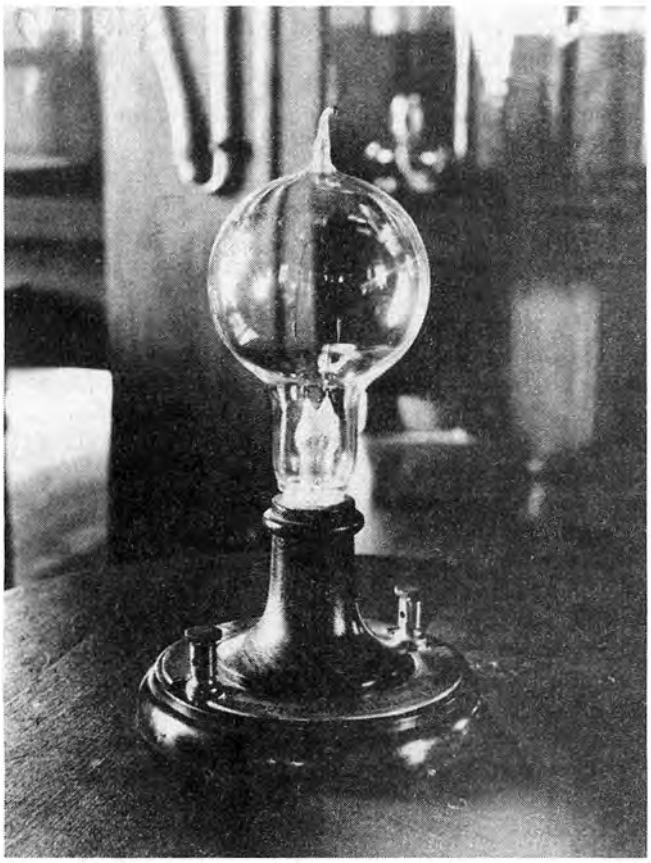
The propagation of electric effects differs greatly, depending on the medium in which it takes place. Indeed, the flow of electrons in the vacuum of a television picture tube, is nothing like the energy transported in the copper or aluminum wires of an electric grid, not to speak of the flow of charges through the strap of a high-voltage Van de Graaf generator.

As a matter of fact, we still do not know what electric currents really are, although we are so familiar with them. (They heat our houses, give us light, power our labor-saving devices in the home, transmit our information, communications, and entertainment—and they also allow us to neglect our multiplication tables, thanks to the calculator.) This ignorance does not just affect the average citizen. It is shared, lamentably, and in a most unexpected way, by many engineers and teachers in the field.

As an example, allow me to recall an experience I had. I had posed at point blank range, to various scientists among my friends, the pedestrian, but somewhat perverse question: "According to you, and without thinking about it, what is the average translational speed of electrons constituting a continuous current of 1 amp passing through a copper wire 1 mm in diameter?"

Their answers were very instructive! Only one was correct to within an order of magnitude. The others fell between some tens of centimeters to hundreds of meters per second. An electronics engineer, who knows his quantum electrodynamics to perfection, and who is not at all ignorant of the Hall effect, or the behavior of Josephson junctions, answered as follows: "I know it is very slow. In these conditions, it can hardly be more than 10 cm/second."

If such a speed of electron flux were possible, the only possible result would be a meltdown of the wire.



"We still do not know what electric currents really are." Here, a replica of the first successful incandescent lamp, invented by Thomas Edison in 1879.

And what do we say about the editor of a large-circulation French magazine popularizing science, whom I will not name out of the goodness of my heart? In answer to a reader's query about the flow of electrons in a circuit, he wrote in his February 1991 issue: "Their velocity of displacement in copper is on the order of meters per second. . . ."

Here you would get more than a meltdown. Considering the amount of energy being brought into play, an explosion, even a deadly one, would have to result. (Below, readers not already in the know, will find the correct value for this velocity.)

This article has been written in response to letters received commenting on my article on anti-gravity, which appeared in the May-June 2000 issue of the French-language magazine, *Fusion* [in English, in *21st Century,* Spring 2001]. There I described the existence of a gravitational anomaly produced by the passage of an electric current through a conducting wire. Various readers, appearing to not know the real conditions of the circulation of free electrons in metals, sent me mail explaining that the results obtained are caused by an inertial effect, which would be caused, for example, by the mass of the electrons impacting where the wire is bent, or on the wire's crystal lattice, but not taking into account that a metal is not a mono-crystal but on the contrary, a mosaic of micro-crystals of diverse orientation.

Therefore, the aim of this article is to criticize these responses and, in so doing, to draw attention to the state of our knowledge of electro-kinetics by demonstrating the existence of numerous paradoxes and inadequacies, which mar this discipline.

Although the application of quantum theories has brought great progress in microelectronics, through the development of transistors and integrated circuits, nonetheless it is still true that at the present time, this theory cannot solve many kinetic and electrodynamic problems, which occur on a more macroscopic scale, and which are, oddly enough, often passed over in silence in works on this topic.

A Very Short History of Electricity

Just as for many other disciplines, one must go back to the ancient Greeks to find the first descriptions of electric phenomena. The term "electricity" *(vis electrica),* was probably created by William Gilbert, physician to Queen Elizabeth and James I of England. It was derived from the Greek "elektron" called yellow amber, a substance which could be rubbed with a cloth or cat's fur, which then would be able to attract small fragments of light materials, by a process which later came to be called electrostatic attraction. In fact, the science of electricity was built up slowly from simple observations of phenomena of this kind.

It is actually not until the beginning of the 17th Century that the first machines which allowed for the production or storage at will of static electricity were constructed: the electrostatic machines of Otto von Guericke and Huyghens, as well as, later, Leyden jars (1745), ancestors of modern condensers. These experiments and more and more precise measurements, above all thanks to Henry Cavendish and Charles Augustin Coulomb, allowed the science to go from the qualitative to the quantitative.

We had to wait however, for the discovery of the electric pile by Alessandro Volta, around 1800, to arrive at dynamic electricity; that is, a "stream" of electric "current" in a conducting medium that could produce significant mechanical or chemical effects. We must also mention the famous experiment of Oersted, which showed the action of electric current on a magnetized compass needle, and marked the beginning of what has been called "electrodynamics."

Progress was made more rapidly as the theoretical connection was made between electricity and magnetism (this also being known from the time of the Ancients), and that thanks to the work of Georg Simon Ohm, and above all of André-Marie Ampère, establishing the rigorous laws of this nascent discipline, which would subsequently benefit by the work of Pierre Simon de Laplace and Carl Friedrich Gauss on the theoretical plane, as well as by the experimental research of Michael Faraday.

But the idea of electric current preceded the arrival on the scene of electrodynamics; it seems to go back to 1746, with Louis Guillame Le Monnier (1717-1799), author of the chapter "Electricité" in the French *Encyclopedia.* Le Monnier, in fact, made the use of the first Leyden jars, to show that a metal wire connecting the electrodes caused the bottle to discharge in a very short period of time. This allowed him to assert that "electric matter" was circulating within the wire at a speed at least "30 times greater than that of sound."

So he had already made the the classic error of failing to distinguish between the velocity of propagation of the shock or disturbance, and the effective velocity of the charges.

Velocity of Electrons In a Conductor

When a continuous potential difference is applied to the two ends of a conducting wire (copper, for example), the free electrons within the conductor are drawn towards the positive pole, resulting in the circulation of a current of intensity *i*. The average velocity, *v*, of these electrons is by definition the distance travelled, *a*, divided by the time, *t*. The number of free electrons present within different conducting bodies is known. For copper, there is one free electron per atom, thus the number of these per cubic centimeter would be:

$$k = 8.5 \times 10^{22}.$$

Let *s* be a right cross-section of the conductor. At the end of time *t*, the free electrons contained in the volume *s.a* will have traversed this section. The number of free electrons contained in this volume is:

$$k \cdot s \cdot a = k \cdot s \cdot v \cdot t.$$

The charge, *e*, of the electron is 1.59×10^{-19} coulombs, and the total charge, *Q*, of the electrons which will have traversed the cross-section *s* is: $k \cdot s \cdot v \cdot t \cdot e$.

By definition, the intensity, *i*, of a continuous current is the number of coulombs which flow per second: $i = Q/t$

Therefore $k \cdot s \cdot v \cdot t \cdot e = i \cdot t$,

and $v = i/k \cdot s \cdot e$.

In terms of current density:

$$j = i/s.$$

So we have: $v = j/k \cdot e$.

Knowing the numerical values of the terms of the second member, it is easy to see that for the usual values of *i* (a current intensity on the order of 1 ampere) and *s* (a cross-section of the copper wire on the order of a square millimeter), the average velocity of flow of electrons is on the order of a tenth of a millimeter per second.

This calculation is inspired by the one given in the *Revue generale d'electronique,* March 1961, p. 47.

It provides us with an order of magnitude, without taking into account such quantum effects as flow from the application of Felix Bloch's theory. It is nonetheless true, that for a conductor made of industrial copper, the number of crystalline faults will be such (Drude's theory) that one can consider the value obtained as being very close to reality.

On the other hand, admittedly, the electric disturbance which the current produces, is propagated, like all electromagnetic effects, at the speed of light.

The Leyden jar stored electricity at a tension, that is, a difference in potential, corresponding to a very large electromotive force (50,000 volts, for example), but because of its high internal electric resistance, it could not provide currents with enough intensity (greater than some microamps) to produce any significant mechanical or chemical effect. But this is not so for the Volta pile, which, for an electromotive force on the order of just a volt per pile element, could produce a current intensity on the order of an ampere or more, depending on the size of the electrodes.

The discovery of the electric pile was, therefore, a true revolution, which made possible all the discoveries which followed. Electrical phenomena were no longer curiosities reserved for the ivory towers of physics, as were those of Abbé Jean Antoine Nollet, or for amusing the salon crowd. They took a growing place in the laboratories, in order to finally flow into the major industrial applications from which our modern civilization currently benefits.

The electricity of the voltaic pile, was not only capable of producing mechanical effects, it was also able to produce chemical reactions, as shown by Humphry Davy, who, in 1812, discovered sodium and potassium by electrolysis. And by a study of electrolysis, Jöns Jacob Berzelius established the basis for an electrochemical theory of matter, showing that any chemical combination is the union of an electro-positive- and an electro-negative constituent.

Thus, we are back again at the dualist conception of electricity of Charles Francois du Fay who, at the beginning of the 1700s, distinguished "vitreous" electricity, from "resinous" electricity. We now know that there are electric charges called "positive" and others called "negative," and that the charges of the same sign repel each other, while those of the opposite sign attract. However, at that time, this interpretation was still very sketchy.

The author in his laboratory.

It was really not until the discovery of the electron and of differently charged particles, that these notions took on some flesh and bones. The discovery of the electron was a textbook case, because it is impossible to attribute the merit of this to only one, or even to a number of researchers. It was, in reality, the collective work and long painstaking efforts by numerous scientists in many different places.

It was above all the study of electric discharges in rarefied gases, conducted by Michael Faraday, pursued by Julius Plücker, and then by Robert Wilhelm Bunsen and Robert Kirchhoff. Subsequently, there was the discovery, in 1886, of the "canal rays" [rays of positive charge] by Eugen Goldstein. Finally, Heinrich Rudolf Hertz, using the best possible vacuum obtainable, discovered "cathode rays"; his work was subsequently taken up by Jean Perrin and then by Joseph John Thomson.

At the end of the 19th Century, two interpretations of these "cathode rays" were counterposed: On the one side, Goldstein, Hertz, and Lenard, considered them—based on the rectilinear propagation of the rays, which could be captured by photographic plates—to be a form of luminous, short-wavelength radiation. On the other side, were William Crookes, Jean Perrin, and J.J. Thomson, who, after having verified that the rays were curved by a magnetic field, took them to be a stream of negatively charged particles. It is evidently this latter interpretation which has prevailed, above all because of a theoretical study by Hendrick Antoon Lorentz, which predicted the existence of these charged particles in accordance with James Clerk Maxwell's electromagnetic theory describing an electric and a magnetic field. George J. Stoney gave them the name *electron,* at first thought of as elementary electric quantities without any inertial mass.

It is the totality of all this basic work, which, after manifold developments, led physicists to assume that an electric current consists of the displacement of a collection of electrified corpuscles—these could be negative ions, positive ions, or simply electrons. The displacement could occur not only in a vacuum, a gas, or a conductive liquid, but also within metals in the solid state, in which case there is virtually no matter being transported other than the very slow translation of the free electrons within the crystal lattice.

Within metals, we are dealing with the transport of a very small mass of material, when the the tiny mass of the electrons and their extremely low velocity of transport is considered (see Box, p. 34).

The measurement of the ratio between the charge and the inertial mass of the electron *(e/m)* was carried out for the first time by J.J. Thomson in 1897. The experiment established the scale of this relationship. A more precise measurement was made by Robert Andrews Millikan in 1908. By other means, the mass of the electron was easily determined to be 1/1,836 that of the hydrogen atom nucleus.

Neither the electron nor other charged particles can be rigorously described outside the quantum framework. However, to remain within the scope of this article, we will more often refer to the pre-quantum physics frame of reference.

Different Types of Electric Current

On the macroscopic level, one can describe the different types of electric current either by the way it is produced, or better, by the medium in which it occurs.

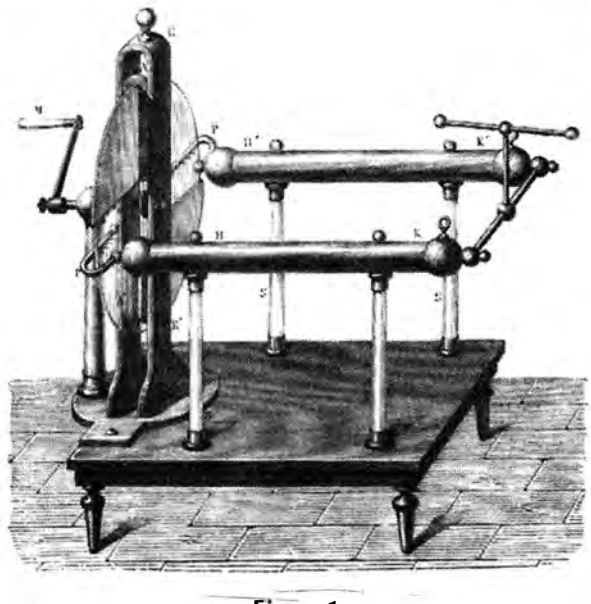


Figure 1
RAMSDEN ELECTROSTATIC GENERATOR
Jesse Ramsden (1735-1800) constructed his frictional electrostatic machine in 1768. It produces electricity by the continuous rubbing of pads on a glass disk. It provides very high voltages but low intensity of current.

(1) Emission in a Vacuum: In a vacuum, electric current consists of a flux of charged particles, generally electrons, emitted, for example, by a hot cathode (Richardson's law of emission), accelerated by an electrostatic field, and moving with a velocity that is a significant fraction of the velocity of light. The potential difference accelerating the charges, is in such a case some thousands or dozens of thousands of volts. This was the case for the cathode ray tubes used in the first experiments, and also for the bundles of electrons in the tubes of oscilloscopes, or television picture tubes. Here, the energy of the emission current is not so much a question of the the number of particles involved (in general a very small number), but their extremely high velocity. The trajectory of each particle can be likened to an [Ampère] current element, in such a way that, by the fundamental laws of electrodynamics, there will be an attraction between the currents going in the same direction, which counterbalances the effect of electrostatic repulsion between particles of the same sign. Thus we find ourselves looking at dynamic structures, that can be focussed in a stable manner, in the form of very small diameter bundles.

(2) Transport of Surface Charges in a Vacuum or in Dry Air: This occurs in the case of Ramsden electrostatic generators (Figure 1), Wimshurst generators (transport on insulated discs), and today, with high-voltage generators of the Van de Graaf type (transport on insulated coils). In these cases as well, the number of charges is very low, but the transport velocity is also low (some meters per second), so that the energies put into play are likewise very slight. Electric generators of this type, for example, allow us to bring a very small number of charges to a

high potential, but in such a way that the current also is very weak. Thus, the intensity of the current produced by such a generator is limited by the need to collect together a great number of charges of the same sign, which repel each other, and yet can only sit on the surface of the body that carries them, all of which clearly places a considerable limit on their number.

In these first two cases, the only law to be applied is $I = Q/T$, in which I is the intensity of the current, Q the quantity of electricity (a function of the flux of a number of elementary charges in motion, across a given cross-section), and T, time. On the other hand, Ohm's law $(I = E/R)$ is not applicable, because the intensity of the current does not depend in any way on the electric conductivity of the medium of circulation.

Behavior of Electrons in A Conductor 'Traversed' by An Alternating Current

In light of what we presented in Box 1 (p. 34), we become aware that in the case of an alternating current, it is difficult to speak of a "current." It's more a question of an oscillation of an ensemble of free electrons, around a configuration of average equilibrium. What is the speed and above all the amplitude of this oscillating motion? For example, let us think about it in terms of current density:

$j = i/s.$

The "current" being alternated at frequency f, the radian frequency, ω, is given by

$\omega = 2\pi \cdot f.$

If the instantaneous density is:
$J = J_{max} \cdot \cos \omega \cdot t,$

and, given the calculations of Box 1, the instantaneous velocity of the electrons could be written:
$v = J_{max} \cos \omega \ t/k \cdot e.$

A barely more complicated calculation would give a value for the amplitude of motion:
$A = J_{max}/k \cdot e \cdot \omega,$

$A = J_{eff}/\sqrt{2}\ k \cdot e \cdot \omega.$

For a value of $J = 5$ *amps/mm*^{2}*, we would have:*
$A = 0.0833/f$ *mm.*

For f = 50 Hz, the amplitude of oscillation of the electrons will be 0.00166 mm. It is thus on the order of a micron.

For f = 1 MHz, it is clearly 20,000 times smaller; that is, it would be less than 1 angstrom. Thus we are not dealing with a current that changes direction, but rather, a vibration of an ensemble of electrons with an amplitude comparable to that of the vibration of ions in a crystalline network

The same is not true for currents circulating within condensed matter, and, in particular, within metals. In that case, the number of the charges that come into play (for metals, the number of free electrons) is incomparably higher. For highly conductive metals, it can greatly exceed 10^{20} per cc. (that is to say, one free electron per atom), because the charge of these electrons, is electrically neutralized by the opposing charge of the ionized atom from which it was liberated, so that the whole conductor remains globally neutral, no matter the number of charge-carrying electrons. Unlike in the previous case, here the notion of electrical conductivity, relative to the number of moving charges, takes its importance. This is why in this case we talk about a conduction current to which Ohm's law is applicable: the intensity of current (I) circulating in a conductor is directly proportional to the difference in potential applied to its extremities (V) and inversely proportional to its electrical resistance (R).

3. Conduction Currents: Hence, what we are dealing with is a current which "circulates" in media called "conductors," which, by looking at their opposite, permit us to define other media, called "insulators." The theory of electrical conduction in metals and in crystalline media is the outcome of the work of a small number of researchers: mainly Paul Karl Ludwig Drude, Ludwig Lorenz, and, above all, Felix Bloch, with collateral help from, for example, Arnold Sommerfeld.

Since the end of the 19th Century (Drude's work goes back to 1900), the theory of electrical conductivity in solid bodies has been based on the idea that electricity was transported by charged particles. The problem was, to find the number of these charged particles, and the nature of the barriers to their displacement by physical-chemical structures and their impurities.

At the beginning of the century, Drude imagined that a metal was composed of almost immobile, heavy ions, and of electrons, which were displaced at random by collisions with these ions. If an external electric field is imposed, the electrons are accelerated, between collisions, in the opposite direction of the imposed field (Coulomb's law), and the average speed of the totality of these electrons ceases to be zero (but remains always very low) in such a way, that as a totality, they become subjected to the imposed field. The density of the current so generated is obtained by multiplying this speed, by the number of electrons per unit volume, and by the electron's charge e. It is thus proportional to the field, and this permits us to find Ohm's law.

This is clearly an overly simplified interpretation, which does not adequately take into account certain experimental facts, for example, the variation of resistance as a function of temperature. We had to wait 20 years for Felix Bloch (Nobel Prize, 1952), to make a fundamental contribution while he was studying this question in the light of nascent quantum mechanics. It seemed that it was necessary to distinguish between certain groups of free electrons, and that within an ionic lattice of definite symmetry, there exist so-called "Brillouin" zones; that is, energy zones that govern electron position. These ideas are most important with respect to semi-conductors.

One of the most curious consequences of Bloch's work relates to his failure to abandon the notion of collision between free electrons and metallic ions. In fact, Bloch showed that in a perfect crystal lattice, electrons must move without resistance. Thus, the mean free path is not limited by

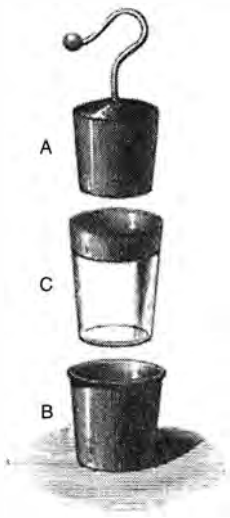


Figure 2
FRANKLIN'S SEPARABLE LEYDEN JAR
To study how the charge is stored in a Leyden jar, Franklin created one that could be taken apart. The assembled bottle is charged, then taken apart, and the two metallic parts (A and B) are grounded. When it is put back together again, it is seen that the bottle still conserves its charge, and therefore that its energy was stored within the glass (C), which serves as a dielectric.

the collisions of the electrons with the ions properly speaking, but by their interactions with impurities, and most of all by the number of faults in a metal's crystal lattice, which often turn out to be mosaics of micro-crystals with various orientations, rather than mono-crystals. Here we meet an astonishing result, which is, unfortunately, not well known. Yves Rocard, for example, in his otherwise excellent book on electricity published in 1951 by Masson, does not even mention it.

Hence it remains one of the apparent paradoxes concerning electricity. There are many others, in particular when it comes to the behavior of dielectrics, and therefore of condensers.

4. The Displacement Current in Dielectrics: During the charging or discharging of a condenser made of dielectric material, significant displacements of the elementary charges are produced, which can be considered as like electric currents. This interpretation, however, does not hold if the dielectric is a vacuum.

There is a long-forgotten experiment which describes dielectrics: that of the collapsible Leyden jar (Figure 2). It shows the primordial role which the dielectric plays in a condenser, for it is within this dielectric that the stored energy of the apparatus is located.

It is likewise a shame that the apparatuses for demonstrating the properties of these condensers, such as, for example, Volta's condenser electroscope, have been abandoned. What was defined at the time was an important property of electricity, the phenomenon called *condensation* (whence the term condenser), whose existence was demonstrated with an apparatus that had movable electrodes, which could be brought close to each other at will. Once a source of tension was connected to them, a constant potential difference, *V,* was established between the electrodes as they were brought closer together. The field, on the order of V/d, where d is the distance between the electrodes, in fact grows in such a way, that by Coulomb's law, the number of charges on the electrodes grows in proportion. Thus, there is more electricity on the electrodes, even though they were subjected to the same potential difference. That is where the phenomenon of condensation of electricity is located. Because it was charged by a continuous current, the condenser conserved its charge, and the properties of its dielectric is such, that the medium thus treated, has induced surplus charges on the surface of the electrodes in question, negative on one side, and positive on the other.

The condenser therefore behaves as a generator of an electric current where the electromotive force is the difference of potential existing between the electrodes. Then all we have to do is reconnect the electrodes with each other with a conducting wire, and, by the fundamental law of electro-kinetics, which says that current has the same intensity at every point of a closed circuit, a current will circulate not only in the external circuit, but also, and with the same intensity, inside the condenser considered as a generator, that is, within its dielectric. But this is an insulator of very great resistivity!

If the capacity of the condenser is high (some hundreds of microfarads, for example, easily realizable today), and if the external electrical resistance is weak, it is then possible to obtain, for a significant fraction of a second, a current of some hundreds of amperes, which necessarily also passes through the dielectric.

This confronts us with a remarkable paradox. Yet, we cannot deny that there must be the equivalent of a current passing through the dielectric, because, in such a case, an elementary calculation shows that the internal electrical resistance of a condenser considered as a generator, is very small—even less than that of an electrodynamic generator of the same dimension, with copper wire circuits. Thus, by the artifice of the condenser's charge, a good insulator was temporarily transformed into an active medium, continuously renewing the electric charge of the electrodes, by we know not what kind of mechanism.

Various theories have been proposed to explain this, after Maxwell's explanation for a vacuum, defining by calculation an "electrical displacement" vector, such that:

$$D = \frac{e\,E}{4\delta}$$

where *e* is the specific inductance, and *E* the field.

If the dielectric is a vacuum, it is evident that the displacement current would be:

$$I = \frac{1}{4\pi}\,\frac{dE}{dt}$$

which does not correspond to any motion of charges. Hence, it would be necessary to conclude that the properties of space have been changed, for there exists, in particular, a transitory magnetic field, because the displacement current must be considered as equivalent to a conduction current.

One thus finds oneself in the embarrassing position of hav-

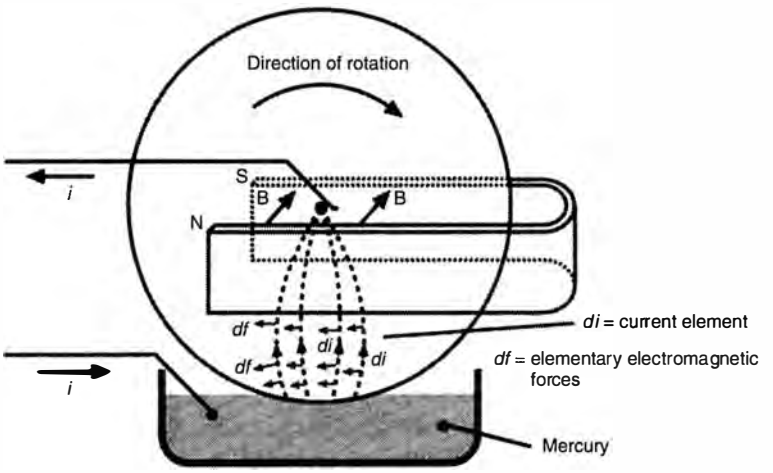


Figure 3
THE BARLOW WHEEL

In a Faraday disk, a current is generated by rotating a metallic disk between the poles of a magnet. The current is drawn from the disk by two contact brushes, one located at the center of the disk and one at the circumference. The Barlow wheel is a Faraday disk where the external contact brush is replaced by a bath of mercury. It thus shows the mechanical linkage between the electron curent and the metal in which it circulates. B *indicates the direction of the magnetic flux, and* i *indicates current flow.*

ing an electric current without any displacement of charges.

We will not take up here the theory of what are, or what are not, dielectric materials; the entire issue of this magazine would not be enough space to exhaust all the implications of this paradox. It remains very real today.

Yet other problems in electrodynamics still remain unresolved. We will mention just a few.

One major problem is the one of the mechanical relationship existing among a flux of charges, the electric current circulating in a conductor, and the material this conductor is made of. In other words, by what kind of mechanical action, is the motion that is imposed upon the current by electric induction (corresponding to Laplace's law), transmitted to the substance that allows the current to exist—that is, the conductor? Frankly, we hardly know a thing about it.

If we are to believe Bloch's theory, such a mechanical coupling does not occur, thanks to the presence of impurities, and above all, because of faults in the metallic lattice which makes up the conductor (if this is so, it becomes hard to see what would happen if this conductor were a perfect monocrystal).

In fact, various experiments show that the electromotive action, in the case of industrial metals, seems to be applied to the conductor itself, such as in the Barlow wheel (Figure 3).

Other experiments, on the other hand, show a certain mechanical decoupling between the current and the material carrying it. For example, the experiment of Tollman and Stewart. A drum with many helices is put into rapid rotational motion around its axis; then the rotation is abruptly stopped. A transitory electrical tension appears at the edges, which would indicate the circulation of a flux of free electrons, carried along by inertia.

What Do We Know?

It would seem that even if we have satisfactory knowledge of the global interaction between currents, we know a lot less about the phenomena taking place within the conductor itself, where that current is circulating.

A macroscopic electric current circulating within a conducting wire, might be considered as made up of a very large number of parallel microcurrents, going in the same direction, which must interact. If the macroscopic laws of electrodynamics are applicable to them, this interaction must take the form of an attraction, limited only by the electrostatic repulsion between charges of the same sign belonging to different microcurrents, and that in a manner comparable to what happens to a flux of electrons in a vacuum. The problem is to know if such a mechanism has a reciprocal action upon the ionized matter of the conductor, in a way that can be measured experimentally on a macroscopic scale.

In fact, this problem was in part resolved by the observation of the *"pinch effect"* by the Americans, affecting liquid metal conductors, as described by Carl Hering in regard to the erratic functioning of electric resistance furnaces. I have analyzed this phenomenon in the French-language *Fusion,* March-April 1995, in an article on Ampére's longitudinal force [in English, "The Battle Over the Laws of Electrodynamics," *21st Century,* Spring 1997, pp. 53-60].

Therefore, attraction between microcurrents can be translated to the level of the whole conductor; the same is true regarding the Ampère longitudinal force acting between successive current elements. When you pass a very intense current (on the order of hundreds of thousands of amperes, in some few milliseconds) through a conductor whose cross-section is on the order of 1 square millimeter, this section breaks into longitudinal fragments, which are produced before any thermally related phenomena could manifest themselves. So, here we have the famous meter-per-second cited in the introduction, with the difference here being, that we are talking about a pulse which does not last more than one ten-thousandth of a second.

These are extreme conditions, which bring into play forces of a considerable intensity.

I have shown that forces of this kind, but significantly weaker, could be created for currents on the order of some amperes, in order to carry out their precise measurement. And, as I indicated in the article in the French-language *Fusion* in May-June 2000 ["Anti-Gravity: Myth or Reality," *21st Century,* Spring 2001, pp. 27-39], these experiments have also brought me to conceive of the existence of a gravitational effect of electric currents.

Tollman and Stewart's experiment could lead to the posing of

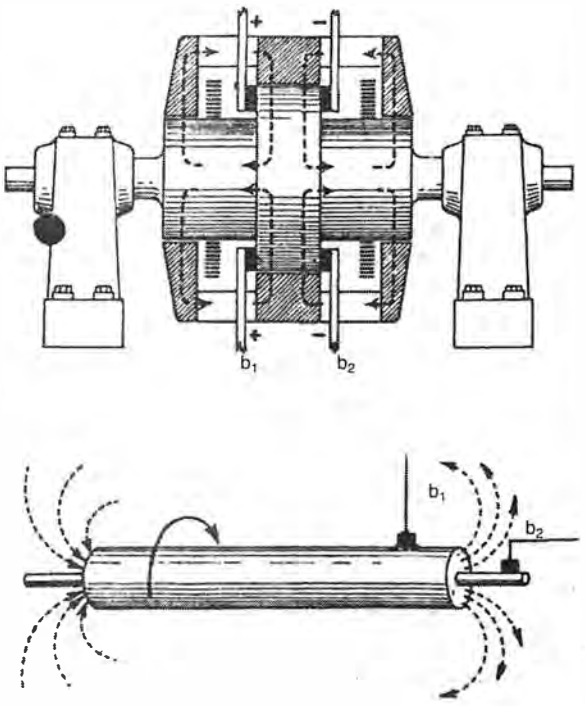


Figure 4
ACYCLICAL HOMOPOLAR GENERATOR

The homopolar generator works on the same principle as the Faraday disk. In this type, brushes come into contact with a rotating cylindrical magnet at b_1 and b_2. It is used to produce very intense currents which can reach 100,000 amps, because unlike the classical (continuous current) generator, it does not need a commutator. On the other hand, its electromotive force cannot exceed some few volts.

the problem of "the weight of electricity." Does the weight of a body increase when it is given an electric charge? Yves Rocard gave a theoretical answer to this question. He showed by calculation that in the case of a leaf of beaten gold, with a surface area of 1 square meter, weighing 1 gram and negatively charged to the maximum possible, the increase in weight would be on the order of 10^{-13} grams. Thus, quite small.

The same thing is true for the purely kinetic energy of the conducting electrons circulating in a metal—this in response to the arguments of certain readers of my preceding article. Considering their very small mass, and above all their very slow collective velocity, their flux for currents of some amperes could not play any purely mechanical role that could be detected by the usual means, scales or dynamometers.

The gravitational perturbation that I observed, and which, for currents on the order of 10 amps, reaches some milligrams, is thus quite another phenomenon, which has nothing to do with the mechanisms described up to this point; my results occur in very particular conditions of dissymmetry of current circulation, of such a kind, that it is permissible to think that here we are dealing with—in the same way as for the dielectrics of a condenser—a transitory modification of the properties of space, and thus an authentic electrogravitic effect.

The paradoxical behavior of the dielectric of condensers, has interested a number of physicists and engineers—for example, Ducretet, Helmholtz, and Lorentz, especially towards the end of the 19th Century. Most of them, however, and probably the more serious ones, hit their heads against the brick wall of experimental difficulties that were too great, with respect to apparent degravitation by dielectric discs charged to a very high tension by electrostatic machines, and they abandoned all research on the gravitational effects of the electricity—being much constrained, as well, by ruling scientific dogma.

And then again, was it not asserted that an electric generator-receiver apparatus, placed on the platform of a balance, does not show any change in weight when the circuit is closed? Even the passage through a circuit of very intense currents, of several thousands of amperes, does not bring about any variation in the measurable weight, if all requisite precautions are taken to eliminate errors of measurement.

Yet, the problem of the action of a current within a condenser's dielectric remains, and a number of investigators have pursued some more or less well-directed work, tending to show that the charge of a condenser modifies its weight. Curiously, the efforts of such "sharp-shooters" have focussed on very high voltages, using only very weak currents, the which provokes peculiarly annoying artifacts caused by purely electrostatic effects being brought into play. It seems however, that even in otherwise bad conditions, an authentic gravitational effect is manifest, which would doubtless be more evident, if they utilized more intense currents.

It seems therefore, that electrogravitation—if there is such a thing—would not be manifested in the conditions of axial symmetry which are made by "closed" circuits.

Only the rupture of this symmetry, such as in my experiments, or such as exists naturally in condensers, would allow us to show it exists, and to subject it to study.

Rémi Saumont is the former head of the biophysics laboratory at INSERM, France's main medical research institute, in Paris. He has continued research work in physics, especially matters relating to the Ampère longitudinal force, as an emeritus director of the lab.

This article appeared in the May-June 2000 issue of the French-language Fusion *magazine, and was translated into English by Richard Sanders.*

Bibliography

F. de Poncharra, 1940. *Théorie électronique du courant électrique*, Dunod.

J. Granier, 1948. *Les Diélectriques*, Dunod.

Y. Rocard, 1951. *Electricité*, Masson.

C.J.F. Bottcher, 1952. *Theory of Electric Polarization*, Elsevier.

E. Durand, 1953. *Electrostatique et Magnétostatique*, Masson.

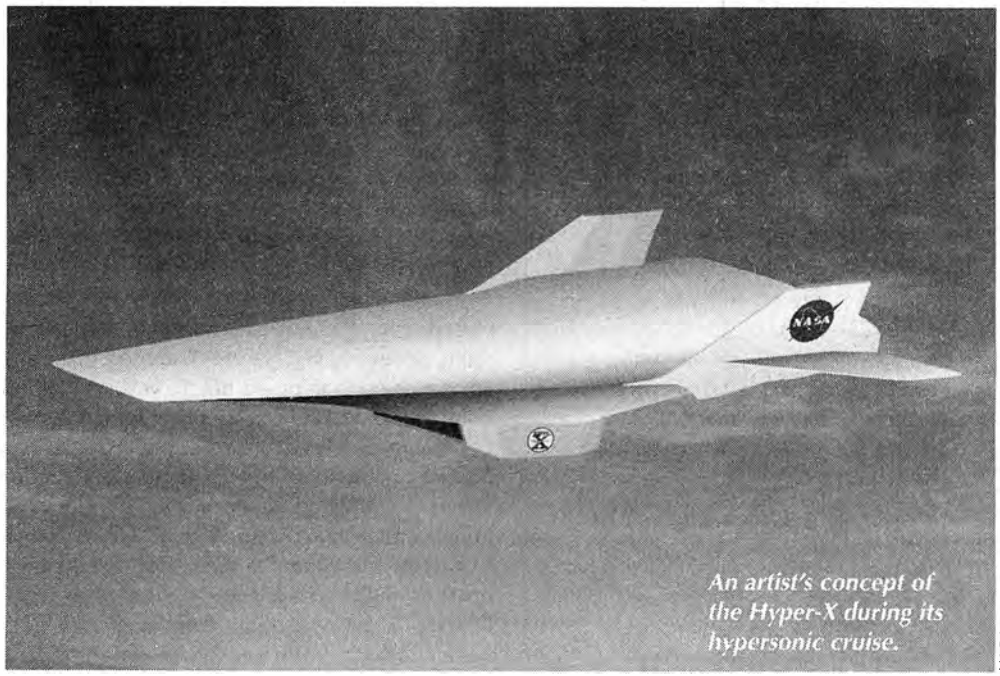
R.H. Bube, 1988. *Electrons in Solids*, New York: Academic Press.

R. Saumont, 1995. "La force longitudinale d'ampère," *Fusion*, No. 55, March-April.

A. Szames, 1998. *L'effet Biefield Brown: histoire secrète de l'antigravité*, Boulogne: Alexandre Szames.

R. Saumont, 2000. "L'antigravitation," *Fusion*, No. 81, May-June.

NASA's Hyper-X



An artist's concept of the Hyper-X during its hypersonic cruise.

NASA

Hypersonic Flight Ready for Takeoff

by Marsha Freeman

NASA's new Hyper-X program combines aircraft and rocket technology to develop a system that will carry more weight, at less cost, into space.

As early as the 1920s and the first rocket experiments, space pioneers were designing aircraft that would be equipped with rockets to fly through the atmosphere into space, and return to the Earth like an airplane. In this way, the airplane frame would use its wings for aerodynamic lift, and the rocket engine would allow it to travel fast enough to go into orbit.

Today's Space Shuttle is an approximation of this concept, using rockets to orbit the Earth, and its wings to aerodynamically glide back. But, because its rockets launch it vertically, the Space Shuttle plows through the atmosphere on its way up, fighting against it, rather than flying through it.

What if technology could be developed to derive the oxygen needed for propulsion from the atmosphere, rather than carrying it along in weighty tanks, the way a rocket does? If engines could be developed that could extract oxygen from the atmosphere and attain hypersonic speeds, only a minimal amount of rocket power would be needed to take the last step into space.

Such a hybrid system would substantially reduce the weight of a space vehicle, making it more efficient and economical. Today, for rocket-propelled vehicles, 88 percent of the take-off weight is propellant. To feed its main engines, the Space Shuttle carries 1.3 million pounds of liquid oxygen in its 15-story-tall

external tank, along with 223,000 pounds of liquid hydrogen fuel. Rocket-powered vehicles have to be designed in stages to go into orbit, discarding excess weight when the fuel is exhausted, which is why the Shuttle drops its external tank.

If the Shuttle could use the air in the atmosphere on its way to space, instead of carrying its oxygen and tank along with it, the vehicle could carry more than a million more pounds of payload. Or, the vehicle could be much smaller, but able to haul the same amount of cargo.

If the space vehicle also took off horizontally, like an airplane, rather than vertically, like a rocket, it could potentially be "launched" from a runway at an airport, rather than from a special space center, further cutting cost. Safety would be greatly increased in this case, because the launch stage would be based on aviation, not rocket technology. If there were a problem with an engine, the plane could fly back to the runway, rather than "drop out of the sky."

Every space agency in the world has been interested in lowering the cost of its access to space, because that cost determines which activities can be carried out. If the cost of orbiting a pound of payload could be one, or, better, two orders of magnitude less than what it is today (about $5,000 per pound on the Shuttle), this would open space to scientific institutions, industry, and even tourists. The cost reduction would ripple through every space activity, from launching satellites, to establishing manned settlements on the Moon, enabling whole new missions.

The National Aeronautics and Space Administration (NASA) is embarked on the Hyper-X program to develop and test the revolutionary technologies that can make the dream of "flying" into space a reality. Under development is a scramjet engine that can take a vehicle to hypersonic speeds, that is, higher than Mach 5, using the oxygen in the atmosphere. (Mach 1 equals the speed of sound, about 760 miles per hour at sea level). If the scramjet engine could bring the vehicle to a speed of Mach 18, only a modest amount of rocket power would be needed to get it to the orbital speed of Mach 25. Hyper-X will be the first flight test of a supersonic ramjet, or *scramjet* engine, and will lay the basis for designing tomorrow's vehicles, that can fly into space.

There have been numerous starts to this space plane project, over the past 50 years. What is needed now, is a crash program commitment to overcoming the very real obstacles in fundamental physical principles—such as hypersonic fluid flow and aerodynamics—and the associated engineering challenges in materials, structures, combustion, and the like. This will require the mobilization of a near-moribund aerospace and aeronautics industry, to rebuild basic research and development resources, enabling the breakthroughs for hypersonic flight.

Rockets on Airplanes

The first proposal for a spaceplane consisted of merely physically joining the two technologies of rocket propulsion and winged flight. In 1923, at the dawn of serious rocket engine experiments, Latvian engineer Fridrikh Tsander described an airplane with a "high-pressure" aviation engine, attached to a rocket. At an altitude of 28 kilometers, he proposed, the aviation engine would be cut off and a rocket engine would take over.

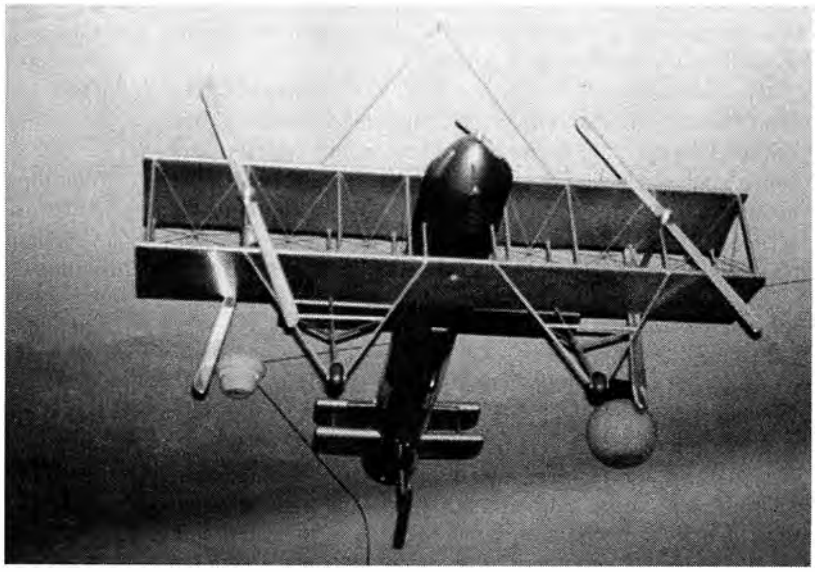
Inside the aircraft would be a smaller, winged spaceship that would be launched into space, later to glide back to land. With aviation still in its infancy, and airplanes that were made out of wood, it would be decades before technology could catch up to this innovative design. Tsander died in 1933, a decade before even the first rocket took flight.

In 1914, a young man born in Bohemia built his first model rocket plane, powered with a fireworks rocket. Eugen Sänger, who was nine years old at the time, went on to read the works of Hermann Oberth and other rocket scientists, and submitted a doctoral thesis at the Technical High School in Vienna in 1928, on high-altitude rocket plane flights. The thesis was rejected by his teacher, who advised that he would be an "old man with a long beard before you succeed in obtaining your doctorate." But this did not discourage the young enthusiast.

The space plane designs of the 1920s followed an approach of starting with a rocket engine and building an airplane around it. Sänger realized that this idea was obvious, but unworkable; that the airplane and propulsion design had to be integrated, to optimize the performance of each.

During the 1930s, Sänger carried out rocket motor experiments at Vienna University, but, according to German-American science writer Willy Ley, he "felt certain then—and future development, has, of course, borne him out—that the practical problems of larger motors would certainly be solvable." Sänger, therefore, left rocket experiments to others, and concentrated on the next step—of marrying the new rocket technology to the airplane.

To Sänger, the logical progression from air to space was through a series of ever-more-capable rocket-powered planes, each of which could fly faster and higher than its predecessor.



Marsha Freeman

This model of Tsander's 1920s winged rocket plane is displayed in the Tsander Museum in Riga, Latvia.

Through successive approximations, the technologies would be developed and the design matured, leading to airplanes in space.

In 1933, when serious rocket engine development work was under way in Germany, Sänger published his book, *Rocket Flight Technique,* in which he presented the design of a rocket plane that could travel for more than an hour at an average speed of 1,600 miles per hour, with an engine burn time of 20 minutes. He called the vehicle the Silver Bird.

In the introduction, Sänger wrote: "In particular, that type of rocket flight shall be treated which takes place in the upper layers of the stratosphere with such velocity that the inertial forces due to the curvature of the flight path contribute essentially to the lift. This type of rocket flight is the next basic development step beyond the tropospheric flight, accomplished during the last 30 years, and it is the prelude to space flight, the greatest technical problem of our time."

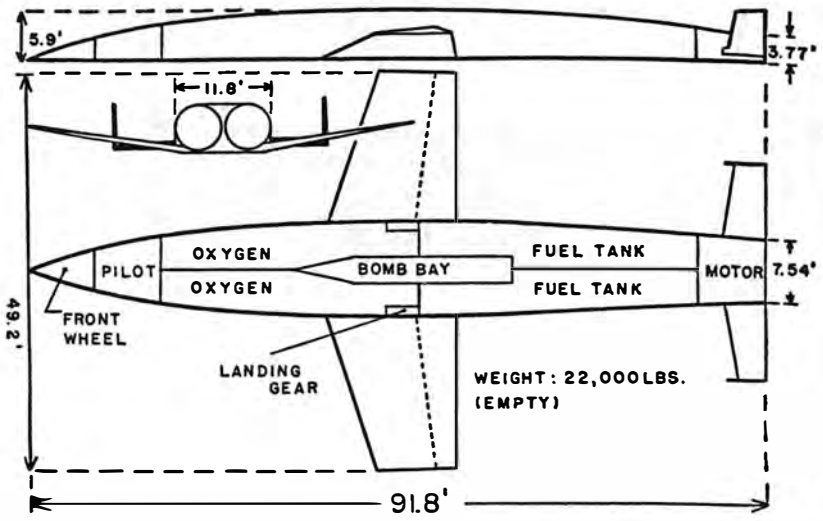


Figure 1
SCHEMATIC DRAWING OF SÄNGER'S ANTIPODAL BOMBER
Eugen Sänger's antipodal bomber was designed to travel halfway around the world and land at an airport.
Source: Willy Ley, 1953

Sänger submitted the proposal for development of his Silver Bird to the Austrian Ministry of Defense in 1933. As Robert Goddard was told by the military establishment in the United States, and Hermann Oberth was told in Germany, so Sänger was told by the Austrian Ministry that rockets would not work.

Two years later, the German Air Force, the Luftwaffe, established a rocket research center in Trauen, Germany, in competition with the German Army rocket research program, later at Peenemünde, to investigate rocket motors. Sänger was invited to join. In 1938, Sänger and mathematician Irene Bredt (later to become his wife) created a steel model of Sänger's Silver Bird, and applied for a patent.

During World War II, Sänger and Bredt worked on a 400-page report titled, "A Rocket Drive for Long-Range Bombers." This concept, based on the earlier Silver Bird, would orbit the Earth using a single-stage vehicle, at a maximum altitude of 186 miles, carrying four tons of payload. A ground-based, liquid-fuelled rocket sled would be used to accelerate the space plane to a speed of 1,640 feet per second, to provide the lift for take-off.

Sänger knew that if the rocket plane were launched vertically, like a rocket, or steeply into the dense layers of the atmosphere too quickly, it would ricochet when its engine were stopped, dropping back to a denser layer, bouncing off it to an upper thinner layer, and repeating this roller-coaster trajectory as it lost altitude. He realized that such a sinusoidal, or "skip" path, would increase the range of the plane, and this led to his concept of the antipodal bomber—Figure 1. (This concept is being used today for flights to Mars, where the drag in the atmosphere "aerobrakes" the spacecraft over a series of orbits, until it lands.)

The single-stage plane Sänger designed is 92 feet long, with a wing span of 50 feet. It would weigh 20 metric tons empty, and carry 80 metric tons, including fuel, a pilot, and 660 pounds of bombs. A two-mile-long straight take-off track on the ground would be used, with the plane seated on a rocket sled. The rocket would operate for 11 seconds to accelerate the plane to a speed of 1,640 feet per second, producing enough lift for take-off. The plane's rocket stage would then be ignited, and accelerate it to a speed of 3.73 miles per second.

Sänger calculated that this vehicle would be able to travel more than 14,000 miles before it landed, going halfway around the world (or to its antipode), and could set down at an airport. The propulsion period would be about five minutes, and the total trip duration, two and a half hours.

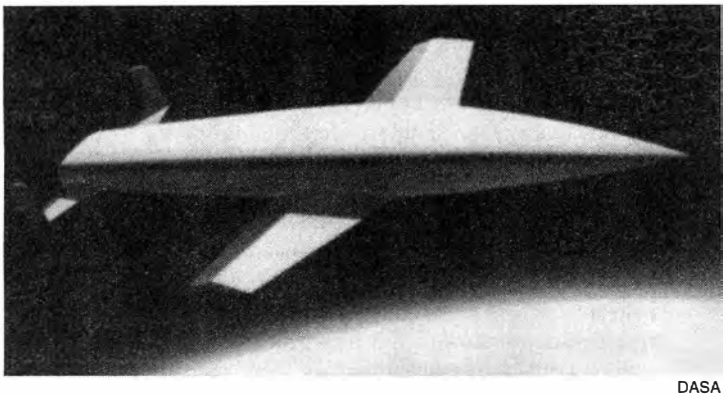
The war ended before such a design could even be considered.

Rocket Planes Begin to Fly

After the end of World War II, and the demonstration of the reality of rocket technology by the team under the leadership of Wernher von Braun at Peenemünde, America's National Advisory Committee on Aeronautics and the U.S. Air Force embarked on a program to test a rocket-propelled hypersonic space plane. This was a path parallel to the pure rocket development program, proceeding under the U.S. Army and von Braun, which was also designed to put man into space.

The purpose of the X-plane program was to develop the technologies and test the flight regimes in the atmosphere, that would be required for manned, orbital rocket plane vehicles.

On Oct. 14, 1947, Air Force pilot Chuck Yeager, sitting in his X-1 rocket plane, was taken aloft by a B-29 airplane to an altitude of 37,000 feet. The X-1 was released from the plane, and ignited its rockets. It was the first aircraft to exceed Mach 1, the speed of sound. That, and the subsequent flights of the X vehicles, provided scientists and engineers with their first test data



DASA

A model of the Sänger-Bredt rocket spaceplan, the Silver Bird.

on the aerodynamics of supersonic flight, the stability of a vehicle in that flight regime, and other information that would be crucial 25 years later in the design of the Space Shuttle. The speed record for manned rocket plane vehicles was set by the X-15 at Mach 6.7, during its 199th flight in 1968.

While the initial testing of supersonic vehicles was under way, ideas abounded on how to apply what was sure to be the next revolution in flight. In 1949, working at the California Institute of Technology, Dr. Tsien Hsue-shen, who would later lead the Chinese space program, designed a suborbital rocket plane to travel from Los Angeles to New York. Rocket burnout would take place after 150 seconds, at an altitude of 100 miles, and the plane would glide for 10,000 miles in about one hour.

Similarly, while working for Bell Aircraft, which built the X-1, former Peenemünde rocketeers Walter Dornberger and Krafft Ehricke designed an intercontinental passenger transport consisting of two winged airplanes, both stages boosted by rocket engines. One hundred thirty seconds after launch, the stages would separate. The manned booster would be flown back to a landing site, and the smaller second stage, with its passengers, would continue on its journey. The plane could be able to cross the Atlantic in 75 minutes, reaching a maximum velocity of 8,560 miles per hour.

With the Dyna Soar (Dynamic Ascent and Soaring Flight), or X-20 program, which began in 1958, the Air Force planned to continue development of hypersonic planes faster than the X-15. But the technical challenges were severe, requiring the development of higher-temperature materials, the mastery of fluid and aerodynamic properties of the upper layers of the atmosphere, and new propulsion systems. Politically, Dyna Soar was seen as unnecessary, because NASA was already developing a manned space program, to lead up to the lunar landing. President John Kennedy had given NASA less than nine years to land a man on the Moon. Ballistic rocket flight was seen as the solution with the lowest risk, and the only way such a timetable could be met. The Dyna Soar program was cancelled in 1963.

As the United States decided to develop ballistic rocket vehicles for manned space flight, Sänger saw a window of opportunity for Europe to exert technological leadership in the space field, by development of the advanced and efficient space plane he had been designing for 30 years. In 1962, Sänger pointed out that the United States and the Soviet Union were concentrating on their race to the Moon. "There is, therefore, at the moment, a unique, but short-lived opportunity for Europe, with its great intellectual and material resources, to become active in a sector of spaceflight in which the major space powers have not yet achieved an insuperable lead," he said. But, in postwar Germany, rocket, space, and military technologies could not be pursued, and, at the time, there was no European-wide space organization to carry through on such a proposal.

In 1961, working at the German aircraft giant Junkers, and then at Dornier, Sänger began a study of space transportation systems, which was completed in 1964. Similar to the Dornberger-Ehricke design, he proposed a two-stage design for a one-man spacecraft for either antipodal flights, or a transport plane, to a 186-mile orbit. Both the booster vehicle and the space vehicle, which would ride piggyback, would be manned and recoverable. The initial lift would be provided by a horizontal catapult, or track, with a pair of rockets. Sänger thought that such a vehicle could be realized within 15 years.

It would be another 20 years before Europe, or at least Germany, would take up Sänger's challenge, but Sänger did not live to guide that effort. He died on Jan. 23, 1964, of a heart attack, while lecturing at the Technical University in Berlin.

On the Other Side of the Curtain

The United States and Europe were not the only places where hypersonic rocket planes were being designed. In an article in *Executive Intelligence Review* magazine in May 1996, Russian space engineer Oleg Sokolov reported on previously secret Soviet aerospace plane projects, dating back to the 1960s. Similar to the situation in the United States, the Soviet space program was focussed on using rocket technology, such as the Soyuz, borrowed from intercontinental ballistic missiles. This was the quickest—and at the time the cheapest—way to achieve Earth orbit.

But the Soviet aviation industry was pursuing the "Spiral" project, initiated in 1965, building on 1950s design experience that had been carried out as the counterpart to the U.S. Dyna Soar program. Spiral was to include a hypersonic airplane-booster, an orbital plane, and an additional booster to take the plane into orbit.

Spiral would have a total mass of 140 tons, and inject the orbiter, with a three-man crew aboard, into low-Earth orbit. The orbiter could carry out two or three revolutions of the Earth, and land at an airfield. The entire system would be reusable. Although the Spiral program was shelved in 1969, and abandoned in 1978, the Russians carried out flight tests of a scale model of the orbital plane in order to study aerodynamic braking, thermal properties, and landing. Tests continued into the 1970s with a variety of analogue vehicles, until the work was shifted to support the development of the Soviet space shuttle, the Buran.

Interest in hypersonic flight reawakened in the mid-1980s, with the focus on using already existing hardware and existing knowledge. The new design, designated the Multi-Purpose Aviation Space System (MAKS), used the Ukrainian conventional super-heavy cargo aircraft Mria as an air carrier. The

orbiter would be dropped from the airplane at a designated altitude and then use its rocket engines to enter orbit. As political and economic chaos engulfed the former Soviet Union, and the Buran shuttle was mothballed because of lack of funds, the MAKS concept went through various iterations, but never came to fruition.

However, Russia and the former Soviet republics today have some of the world's finest expertise, not only in rocket plane design, but also in hands-on experience in designing and testing some of the most advanced engines for the future. That expertise is ready to be re-engaged in an aerospace plane project.

The 1980s Sänger II

In 1984, President Ronald Reagan committed the United States to help develop a space station in low-Earth orbit, and he invited international partners to join the project. This initiative opened up the possibility of new missions for relatively small manned spacecraft that could be used to deliver crew members, and service the permanent space facility. In addition, the 1986 Challenger explosion prompted nations involved in the station to have second thoughts about the policy of relying solely on the Space Shuttle to take astronauts into space. (Russia did not join the project until early 1990s.)

German aeronautics and space engineers resurrected the project for an aerospace plane, and honored the originator of the concept by naming it the Sänger II. The Sänger program, begun in 1986, had the goal of developing hypersonic engine technology (above Mach 5), including a vehicle that would take off from an airport, release a second, orbital vehicle to visit the space station--or provide a ride to a transfer orbit for payloads, such as a communications satellite, headed for geosynchronous orbit, 24,000 miles above the Earth—and then fly back to land.

The German program was designed to make use of available, or near-term technology, by employing a two-stage configuration. The first stage, a large booster plane, used a conventional jet turbine engine, and then switched to a ramjet, fuelled by liquid hydrogen, which would obtain speeds up to Mach 7. At that point, the second, smaller space plane would separate, and ignite its rocket engine to obtain orbit.

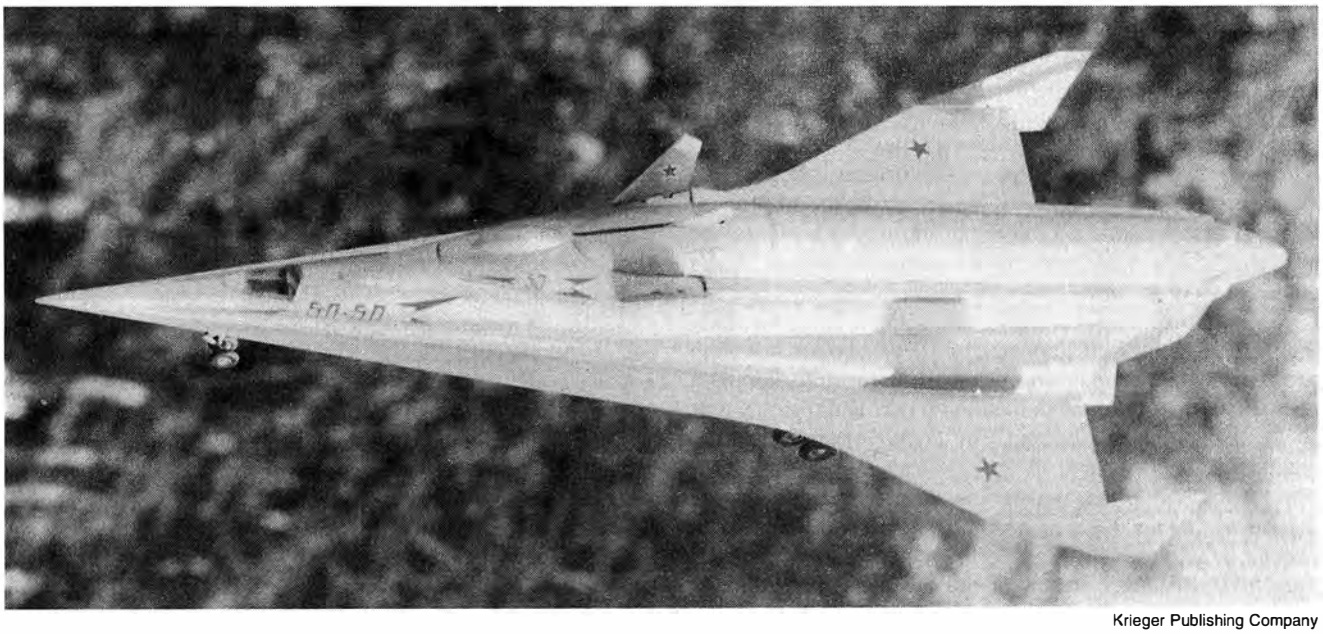
Today's jet aircraft, commercial and military, use turbojet engines that compress the air in the atmosphere, combine it with fuel, burn the mixture, and expand the combustion products to produce forward thrust. But these engines are limited to speeds of about Mach 3. Above that speed, the turbine blades used to compress the air, overheat. Unlike turbojets, ramjets have no moving parts.

In ramjets, the air is channelled into the engine through an intake duct pointing in the direction of flight. It requires no moving parts, because the air is compressed by the forward speed of the aircraft itself. The air enters a combustion chamber where it is slowed down as it is rammed into the chamber. As it slows, the pressure increases and the gas expands. Even without combustion, the air is heated to 1,100°C for flights at a speed of Mach 5.

Ramjets had been under development for nearly 40 years. In 1946, Sänger went to France, to advise the government on rocket technology. While there, he carried out research and tests on ramjet engines towed by an airplane.

The ramjet concept had been originally explained by René Lorin in 1913, and was patented in 1941 in Germany. Preliminary tests were conducted in Germany between 1942 and 1944. In his 1965 book, *Space Flight,* Sänger pointed out that rocket vehicles consume 60 percent of their propellants in altitudes less then 30 kilometers, in the densest part of the atmosphere, on their way to space. Tremendous savings could be won by replacing rockets that carry along their oxygen, with turbojet and ramjet engines that use air from the atmosphere, up to that altitude.

Sänger explained that three different propulsion systems would be needed in his spaceplane design. Because ramjets are efficient only at about Mach 2 and above, conventional turbojet engines are needed for the first leg of the flight. And,



Krieger Publishing Company

The Soviet "Spiral" aerospace plane, which included a hypersonic airplane booster and small orbital plane on top.

University of Vienna

An artist's drawing of the two-stage Sänger II, with its hypersonic ramjet first stage and space plane.

because ramjets have been shown to operate effectively up to a speed of about Mach 6, rockets would be needed for the last leg into space, reaching Mach 25.

Sänger stated that the goal was to increase the payload weight of a space vehicle to 15 to 20 percent of the total weight, similar to that of a commercial airliner. Ballistic space vehicles represent "a primitive, uneconomical, and unreliable initial stage of the development program," he wrote.

The Sänger II design included an air-breathing hypersonic ramjet for the first stage, which could, by itself, be an intercontinental transport plane. Carrying 130 passengers, it would have a range of 13,000 km, a 33-foot wingspan, and six ramjet engines, and it would reach a maximum speed of Mach 6.8 and a cruising speed of Mach 4.5.

The smaller, second-stage rocket-powered plane could be designed for either a crew of two, or for cargo. The Horizontal Upper Stage (Horus) was the manned version, while the Cargus would carry up to 15,400 pounds of freight. Preliminary models of the ramjet engine were tested in wind tunnels at a speed of Mach 4.7.

As a result of both technical and financial difficulties, the Sänger II project, entirely funded by the German government and industry, was stretched out; the first, technology-development phase extended from 1992 to 1995. This challenging phase required the development of air-breathing propulsion, advances in aerothermodynamics, propulsion integration with an airframe, and new materials and structures. It was estimated that the last phase, a flight-ready vehicle, would cost $20 billion.

From the beginning of the program, Germany made it clear that international collaboration would be required to advance to the second stage of building scale models for testing and, eventually, a full-scale test vehicle. While partners for the program were being sought, the German space budget was reduced 20 percent in 1993, other necessary parts of the program were dropped, and only research on air-breathing engines continued. The European Space Agency, contending with competing concepts from France and England, and in the end unwilling to fund any one of them, did not approve the program. Foolishly, Sänger II was cancelled in 1994.

From Ramjets to Scramjets

In the mid-1980s, the United States began the National Aerospace Plane program, dubbed the "Orient Express." It had been announced as a national initiative by President Reagan in his 1986 State of the Union address. The goal of NASP, or the X-30, was to demonstrate the feasibility of "sustained hypersonic cruise," in a most difficult single-stage-to-orbit configuration. This would mean that subsonic aircraft propulsion, and air-breathing hypersonic ramjet and scramjet propulsion, would all be integrated into one vehicle. This had never been attempted before. The program was to culminate in a full-scale flight-ready vehicle. The estimated cost was $10 to $15 billion.

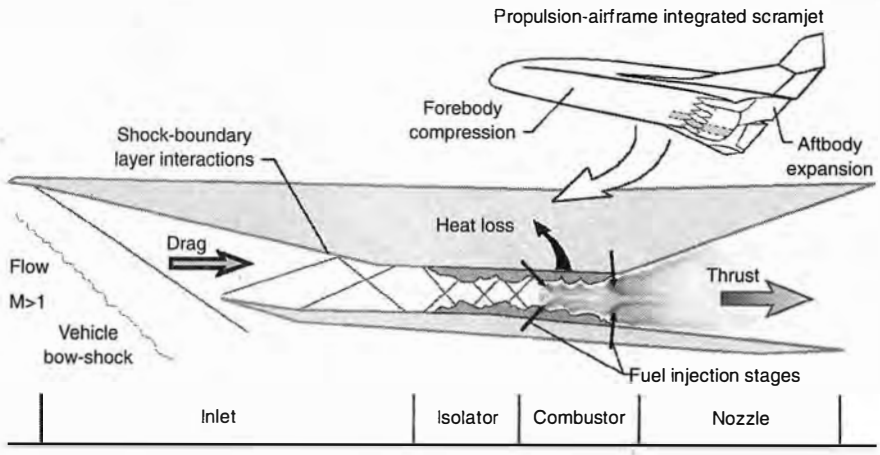
It was known from previous tests that at six times the speed of sound, the combustion chamber in a ramjet engine becomes so hot that the combustion products needed for thrust, decompose. At that point, a more advanced propulsion system is needed to take over.

Scramjets, or supersonic ramjets, were the invention of Antonio Ferri, working at New York University in the late 1950s. In the United States, his work led to the 1960s Hypersonic Research Engine program at NASA's Langley Research Center in Virginia. Unlike the ramjet, the air coming into the engine is not "rammed," to slow down, but stays at supersonic speeds throughout the engine. This prevents the air flow from heating up, keeping it relatively cool. But, it reduces the time the air spends in the chamber to one-thousandth of a second, or less. A very quick chemical reaction is required in the chamber, with hydrogen the most effective candidate. It was well known that this would be a challenging technology to understand and engineer.

As the National Aerospace Plane program proceeded, it became clear that the technical challenges in developing a hypersonic scramjet engine—which had to be flight tested, because no wind tunnel exists that can test anything higher than Mach 8—were greater, and much more expensive, than originally calculated. The program also ran into political problems in Washington. With Defense Department budget cuts in 1989, Defense Secretary Dick Cheney tried to cancel the X-30 program during his first week in office. The program limped along from year to year, tossed back and forth between the Air Force and NASA, never receiving enough political support, or funding.

By 1993, it was clear that only (expensive) test flights could accurately characterize the shock wave transition point for the

Figure 2
HYPERSONIC SCRAMJET ENGINE INTEGRATED INTO AN AIRFRAME
As the hypersonic scramjet travels at Mach 7, the hypersonic flow of air encounters the forebody of the plane, creating shock waves. The shock waves compress the air flow, slowing the air down to about Mach 3, before it enters the engine. Fuel is injected into the air flow in the combustor, and thrust is produced as the combustion products expand and exit the rear of the aircraft.
Source: NASA Langley Research Center



X-30; provide test data on scramjet performance at high Mach numbers, prior to manned X-30 flights; and overcome the lack of data to support the claims that hypersonic vehicle stability and control were manageable. The program was behind schedule and over budget. Members of the technical community felt that NASA and the Air Force had bitten off more than they could chew, and that substantially more research and development was necessary before development of test flight vehicles could be entertained.

While progress was made in a number of areas, and scramjet wind tunnel tests were successfully conducted, the program was essentially ended in 1994. Although it was intriguing to propose flying from New York to Tokyo in one hour, a well-funded, longer-term R&D effort, with the stable political backing of Washington policymakers, was lacking.

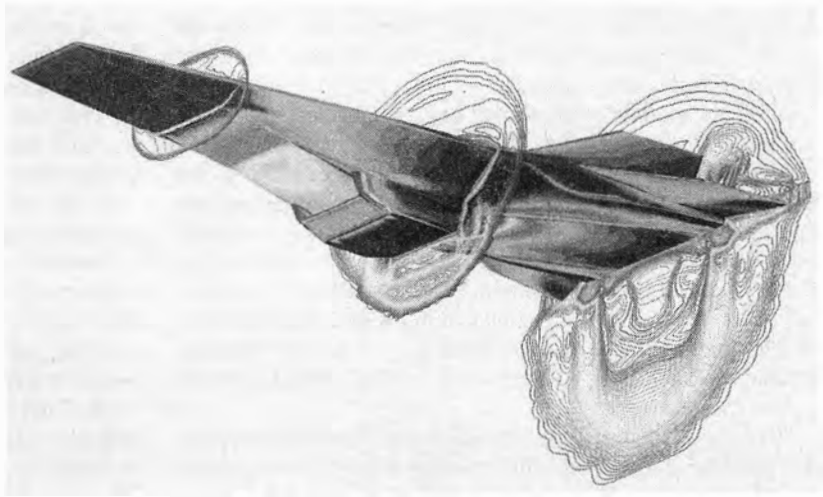
A similar situation existed in the Soviet Union, where work on hypersonic engines had been under way. There, on Nov. 28, 1991, for the first time in history, an air-breathing ramjet/scramjet engine was tested in flight. The engine, launched on a missile, operated for 20 seconds, and attained a speed of Mach 8. A second test took place the next year, prepared by the Central Institute of Aviation Motors, the Tupolev aircraft design bureau, and the famed Central Aero-Hydrodynamics Institute (TsAGI). At a speed of Mach 6.6, the ramjet engine converted to a scramjet. Scale models of potential airframe designs were tested in the wind tunnel at TsAGI, up to speeds of Mach 20, for two minutes.

The resources have not existed in Russia to complete the development that is possible on the ground, and then to move to test-flight articles to verify the revolutionary new propulsion technology. As early as 1993, Russian scientists proposed that their extensive, ground-based hypersonic test facilities be combined with the American capabilities in fields such as computational fluid dynamics, in a joint program to develop hypersonic flight. Now that NASA has initiated such a program here, this proposal should be implemented.

When the National Aerospace Plane program was ended in 1994, it did not diminish NASA's interest in completing development of the technology. Within the next 10-20 years, the Space Shuttle fleet will reach the end of its productive lifetime. The challenge is not only to replace the Shuttle, but also to radically reduce the cost of manned access to space. In 1995, NASA began Hyper-X, a more modest, $185 million five-year technology development effort, starting from the progress made in the NASP (National Aerospace Plane) program.

Hyper-X: From Earth to Space

The goal of the Hyper-X program is to design and test scramjet propulsion systems in wind tunnels and integrated with a small-scale vehicle. If these are successful, a decision will be made to proceed with a full-scale flight vehicle. Conceptual design work began in 1995, and wind tunnel tests of engine models followed early in 1996. Fifteen experimental aerodynamic test programs, on 11 different models, were tested during more than 1,000 runs, to validate a scramjet design. In 1977,



Beyond a speed of Mach 8, where the ability to test in wind tunnels is lost, scientists use computational fluid dynamics to analyze air flow and shock fronts around hypersonic aircraft. These are diagrammed here with the Hyper-X.

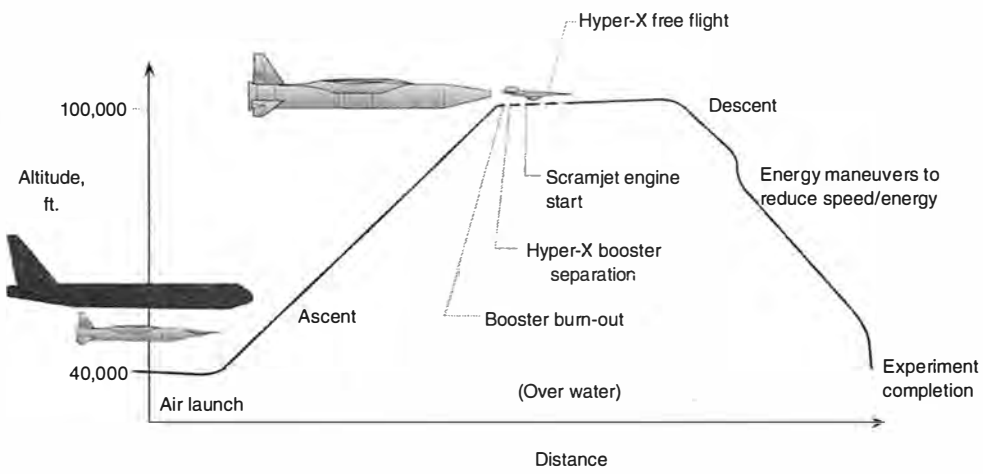


Figure 3
SCHEMATIC OF HYPER-X FLIGHT TRAJECTORY

During a flight test of the Hyper-X, or X-43, a B-52 flies to 40,000 feet, where it releases the X-43, which is attached to a Pegasus rocket. The rocket ascends to 100,000 feet, and the X-43 flies using its scramjet engine after release from the Pegasus.

Source: NASA

NASA chose MicroCraft, Inc. of Tullahoma, Tennessee, to develop the X-43 test vehicle, in order to integrate the scramjet engine with an airframe. Three vehicles have been built, each approximately 12 feet long, with a wing span of about 5 feet.

In order to test the scramjet engine, the X-43 is carried aloft attached to a Pegasus rocket booster, under the wing of a B-52. At a speed of Mach 7, when the B-52 reaches a height of about 40,000 feet, the Pegasus, carrying the X-43, is released from the plane. At an altitude of 100,000 feet, the X-43 is then released from the Pegasus, and turns on its engine for 10-plus seconds. In its unpowered, six-minute glide phase, it is to perform a number of "S" curves to slow itself down aerodynamically, and finally ditch in the Pacific Ocean.

The three X-43 aircraft, although appearing identical, will be engineered with slight differences to simulate variable air inlet scramjet geometry, which changes with Mach number. Two vehicles were designed to fly at Mach 7, and the last at Mach 10, or 7,200 miles per hour.

The first such flight test took place on June 2, 2001. But after separation from the B-52, the Pegasus rocket booster went out of control 5 to 8 seconds after igniting, and range safety officers ordered the rocket, with the attached X-43, to self-destruct. While NASA is investigating the cause of the test failure, the schedule for the next two test flights, which were supposed to proceed at six-month intervals, has been put on hold.

The second phase of the Hyper-X program will use a slightly larger X-43 vehicle, for follow-on tests in the Mach 5 through Mach 7 regime. These tests will actually be more difficult than tests at Mach 7 or 10, because they will take place in the transition region between supersonic and hypersonic speeds, during which the engine will have to make the transition from a ramjet to the scramjet. That program will be centered around a hydrocarbon-fuelled scramjet, which is being developed by the Air Force Research Laboratory. The project, led by NASA's Marshall Space Flight Center, is planned to start in October 2001.

Each mode of air transportation has a regime in which it operates most efficiently. Today's turbojet engines are designed to operate at relatively slow speeds, in the densest part of the atmosphere, using mechanical means to provide air compression for forward thrust and lift. At the temperature and speed limit beyond which rotating turbines become operable, ramjets, with no moving parts, can accelerate a plane to up to six times the speed of sound.

Beyond the reach of the ramjet, where air and combustion temperatures extend beyond the limits of today's heat-resistant materials, and combustion becomes inefficient, supersonic ramjets, operating at cooler temperatures, can bring a plane to the edge of space.

Up to now, scramjet engines have been tested in the United States only in wind tunnels. Because of the complexity and nonlinear character of hypersonic aerodynamics, only *in situ* tests will prove any particular design. The Hyper-X program will be the first to take the step to integrate advanced air-breathing engines with an airframe.

Considering all of the theoretical and experimental work that has been done, particularly in the former Soviet Union and in Europe, NASA's Hyper-X program would certainly benefit from an international effort.

Nearly 80 years after the first rocket plane concept, and more than 50 years since research began on revolutionary air-breathing engines, it is time to open the age of hypersonic flight!

Marsha Freeman is an Associate Editor of 21st Century. *Her most recent book,* Challenges of Human Space Exploration, *was published by Springer Praxis in early 2001.*

References

Gunter Beyes, 1987. "Eugen Sänger: Astronautical Pioneer and Trailblazer," *EIR* (Feb. 27).

Krafft Ehricke, 1960. *Principles of Guided Missile Design* (Princeton, N.J.: Van Nostrand Company).

Marsha Freeman, 1998. "The Contributions of Fridrikh Tsander: A Memoir," presented at the 49th International Astronautical Congress, Sept. 28-Oct. 2, 1998, Melbourne, Australia.

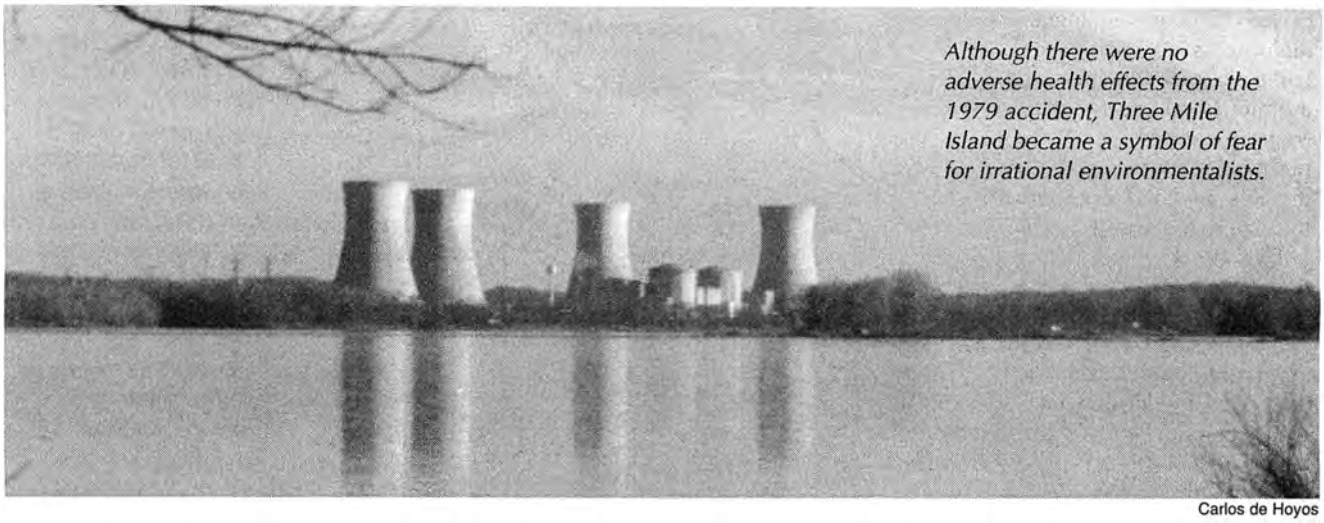
Russell J. Hannigan, 1994. *Spaceflight in the Era of Aero-Space Planes* (Malibu, Fla.: Krieger Publishing Co.).

Willy Ley, 1953. *Rockets, Missiles, and Space Travel* (New York: The Viking Press).

Ron Miller, 1993. *The Dream Machines* (Malibu, Fla.: Krieger Publishing Co.).

Eugen Sänger, 1965. *Space Flight* (New York: McGraw-Hill).

Oleg A. Sokolov, 1996. "By Aerospace Plane into Space and Back," *EIR* (May 17).



Although there were no adverse health effects from the 1979 accident, Three Mile Island became a symbol of fear for irrational environmentalists.

Carlos de Hoyos

The Significant Health Benefits Of Nuclear Radiation

by Jerry M. Cuttler, D.Sc.

Many of the negative images of nuclear energy, especially those developed since the 1979 Three Mile Island accident, relate to perceptions of adverse health effects, specifically the possibility of inducing cancer and genetic damage, from any exposure to ionizing radiation.[1] The irony is that we are continuously exposed to radiation from natural sources.

Do exposures from human-made sources really significantly increase the normal incidence of cancers and birth defects? What about the beneficial health effects from low doses we've been hearing about? The answers to these questions are important because humanity now faces severe environmental, energy and medical issues, which greatly affect our quality of life. Nuclear technologies can provide realistic remedies, but fear about exposures to any human-made radiation greatly constrains their application.

We in the nuclear community make arguments about relative risks, but people make their own judgments about the acceptability of various risks, regardless of our comparisons. It would be possible to gradually change public notions about nuclear technology if, instead of trivial risks, a different, more positive picture of radiation's significant beneficial health effects could be communicated. The problem is strong resistance from influential scientists in recognizing the real benefits and discounting insignificant risks. This has led to a raging controversy over the past decade, and pressures from many scientific organizations to change regulatory policy.

The facts, as I will show, are quite clear. When the controversy will be resolved is unclear.

Radiation Carcinogenesis and LNT

The German physicist Wilhelm Röntgen discovered X-rays in 1895, and the French physicist Henri Becquerel discovered radioactivity in 1896. Since then, a tremendous amount of research has been carried out on the effects and aftereffects of ionizing radiations, and many very important applications have been found. Harmful health effects following large exposures were identified, almost immediately, and radiological protection advice was issued and updated, as more accurate information became available.

The early recommendations were concerned with avoiding burns and delayed effects from intense short-term radiation. This involved defining a safe limit for exposures (for example, ~0.2 rads per day in 1934 and 0.3 rads per week in 1951) based on the concept of a threshold. (See box, p. 49.) By 1955, this threshold concept was rejected by the International Commission on Radiological Protection (ICRP), which adopted instead a concept of cancer and genetic risks, kept small compared with other hazards in life.

"Since no radiation level higher than natural background can be regarded as absolutely 'safe,' the problem is to choose a practical level that, in the light of present knowledge, involves negligible risk."[2] This change in philosophy

---

Dr. Cuttler, a nuclear engineer, works as a consultant in Ontario, Canada. He is a past president of the Canadian Nuclear Society. This article was adapted from a speech he gave at the Annual Conference of the Canadian Nuclear Society in Toronto, June 2001.
jerrycuttler@home.com

was brought about by new biological information—epidemiological evidence of *excess* cancer malignancies among radiologists and indications of *excess* leukemia cases in the survivors of the atomic bombings at Hiroshima and Nagasaki—"stochastic effects," whose probability of occurrence, not the severity, was assumed to be proportional to the size of the dose.[2]

This is the origin of the linear no-threshold or LNT model of radiation carcinogenesis. It derives from the hypothesis that a single impact of ionizing radiation on a cell causes an alteration, which could develop into a mutation, which could eventually become the first cancer cell in a tumor, which then could cause death. The likelihood of this transformation, from a normal cell to organism death, is assumed to be proportional to the radiation dose.

Statistically significant data on excess cancer deaths, which follow exposures to high radiation doses, are fitted by a straight line, which is then extended down to zero dose. This straight line goes through the entire lower-dose region where there was *no statistically significant* human data.

The LNT model for an acute (short-term) exposure is shown in Figure 1. This model is generally used to calculate the excess number of cancer fatalities following exposure to a low dose from a (human-made) source of radiation. A risk reduction factor, in the range from 2 to 10, may be applied to the integrated dose of a chronic (long-term) exposure at a low dose rate.

The increase in the average dose (above natural background radiation) received by the population from the human-made source is evaluated, and this average dose is multiplied by the slope of the LNT line to predict the increase in the normal fraction of these people who will die from cancer, instead of from a different cause. (In Canada, this is approximately 28 percent.) The incremental exposure received by a person from a human-made source is multiplied by this factor to determine his/her increased risk of dying from cancer.

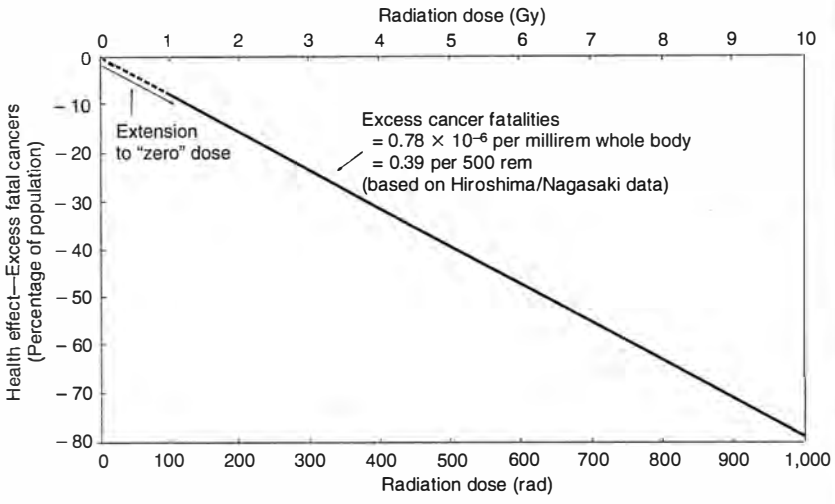


Figure 1
THE LINEAR DOSE-RESPONSE MODEL FOR RADIATION-INDUCED CANCER

The linear dose response model for calculating the risk of death from cancer as a result of radiation dose, takes the known cancer death rate from high doses, and extrapolates it down to "zero" dose (upper left of graph). This is done despite the fact that there are no data showing increased cancer risk at the lower dose region.

Source: Cuttler (Ref. 22)

Non-linear Effects and Non-scientific Influences

It is fascinating to review the early investigations that were carried out to determine what radiation does to living things. Thousands of these studies revealed a variety of beneficial health effects after exposures to low doses. Many people actually began to consume small amounts of a radium solution, sold in bottles as an elixir, until the practice was stopped after several well-publicized cases of radium poisoning caused by overconsumption.

Epidemiology on the famous radium dial painters by R.D. Evans identified a maximum body burden of radium (0.1 Ci), including a 10 to 100 safety factor, and a threshold (lifetime) skeletal dose (approximately 1,000 cGy), below which no long-term excess cancers or other adverse effects appeared.[3, 4]

Why was the very large amount of scientific information on beneficial effects and on thresholds for adverse effects ignored when the LNT model was formulated, and ignored again when more research was carried out?

To understand the answer, we have to consider the social and political environment at the time when the new radiation protection recommendations were formulated. Scientists were agonizing over their roles in the development and

How Radiation Is Measured

Radiation "dose," or "exposure," is a measure of energy absorbed per unit of mass. There are two sets of units used, the older units having been renamed.

For equivalent tissue damage from different types of radiation, the rem was defined as "rad equivalent man"—or rad times a quality factor. For gamma and beta radiation, the quality factor for most significant energies is 1, so "rad" and "rem" are taken as equal in these cases. For alpha rays and neutrons, the quality factor is greater, indicating that there is more damage from the same absorbed energy.

New unit	Old unit	Equivalent used here
1 gray (Gy) =	100 rad =	100 cGy (centi-gray)
1 sievert (Sv) =	100 rem =	100 cSv (centi-sievert)

actual use of atomic bombs in war. The creation of large stockpiles of more powerful nuclear weapons in several countries raised enormous moral issues and fears about their potential use.

Scientists realized they could not put "the genie back in the bottle," so they began to campaign against further A-bomb development, testing, and production, and for nuclear disarmament. Concerns began to be expressed about potential, long-term adverse health effects following exposures to very small amounts of radioactive fallout. Until that time, the information about beneficial health effects and thresholds had not been rigorously scientific.

Over the past 50 years, however, many research programs were carried out to study the incidence of adverse biological effects, measured at high doses and extrapolated linearly to zero dose. During the past 30 years, many observations of beneficial health effects were either ignored or suppressed.[5]

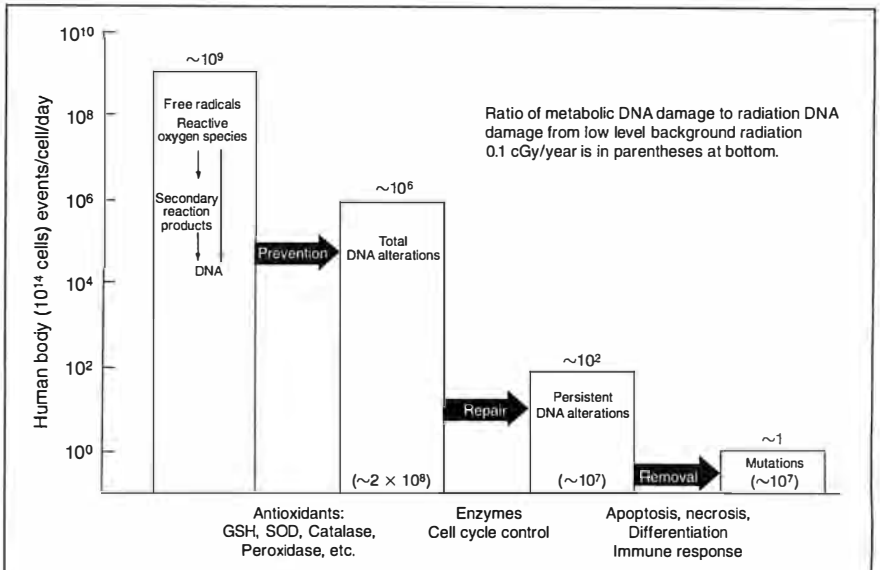


Figure 2
BIOLOGICAL MODEL OF DNA DAMAGE-CONTROL SYSTEM AT 0.1 cGy/YEAR NORMAL RADIATION

Low doses of radiation stimulate many cellular functions, including oxidation damage prevention, enzymatic repair, and immunological and apoptotic removal of DNA damage.

Source: Pollycove and Feinendegen (Ref. 11)

Atomic Bomb Survivors

The principal scientific evidence that supports the LNT model is the 1950-2020 Life Span Study of cancer mortality among the Hiroshima-Nagasaki survivors. The two A-bombs dropped in August 1945 killed between 150,000 and 200,000 of a total population of 429,000 people.[6, 7] The Life Span Study sample of 86,572 people contains roughly half of the survivors who were within 2.5 km of the bombs.[8]

Based on the many concerns expressed over the past 50 years about the risk of fatal cancers from nuclear radiation, how many of the A-bomb survivors would we expect to have died from cancer, in excess of the normal incidence of cancer? Several people I asked recently indicated they would expect that in excess of 20 to 50 percent of the survivors would have died!

So, let us examine the recent data in Table 1.[8] It is very surprising to note only 334 *excess* deaths, 40 years after the event, among this very large group! Now, 36,459 people were far enough away to have received no significant radiation exposure, so we might consider the fraction 334 ÷ 50,113 = ~ 0.7 percent, or 334 ÷ 7,578 = 4.4 percent as the attributable risk. But the authors of this Life Span Study prefer the ratio [334 – (–42)] ÷ (7,578 – 3,013) = 8 percent. Of this group, 56 percent were alive in 1991, and 38,092 had died. So we could conclude that ~1 percent of them died from radiation-induced cancer.

Survivors under 20 years of age at the time of bombing constitute 40 percent of the population, but a much smaller fraction of the deaths, because cancers generally occur late in life. The final results will depend strongly on what happens to these survivors as they enter their cancer-prone years after age 50.

Those over 50 at the time of bombing did not live long enough to show evidence of radiation-induced cancer, because of the ~20 year latency period.

A-BOMB SURVIVORS' OBSERVED AND EXPECTED DEATHS FROM SOLID CANCERS (1950-1990)

Dose (Sv)	Dose (rem)	Number of Subjects	Observed Deaths (1)	Expected Background (2)	Excess Deaths [(1) – (2)]	Statistical Uncertainty* √ (1) + (2)
0	0	36.459	3,013	3,055	--42	78
0.005-0.1	0.5-10	32,849	2,795	2,710	85	74
0.1-0.2	10-20	5,467	504	486	18	31
0.2-0.5	20-50	6,308	632	555	77	34
0.5-0.10	50-100	3,202	336	263	73	24
1.0-2.0	100-200	1,608	215	131	84	19
>2.0	>200	679	83	44	39	11
	Totals:	86, 572	7,578	7,244	334	

Among the atomic bomb survivors in Hiroshima and Nagasaki, there have been only 334 deaths from cancer in excess of the normal incidence of cancer in the population. Also, there are no significant excess deaths below a dose of 1 Sv (100 rem).

Source: Pierce et al. (Ref. 8) * My rough assessment—J.C.

Leukemia was the first malignancy to appear. By 1985 almost all the radiation-induced leukemias to be observed were recorded; the number of excess deaths determined is 87.

Nuclear scientist Ralph Lapp states there were approximately 300,000 survivors in 1950 when the Life Span Study was undertaken. He estimates that in 2020, about 800 will have died from A-bomb radiation, or about 0.3 percent of the Hiroshima-Nagasaki population. Because one of every four survivors (or 75,000) will die of cancer, one in a hundred of these deaths will be caused by the A-bomb radiation.[6]

A rough assessment of the statistical uncertainties (standard deviations) of the excess deaths in the table, indicates that they are quite large, below doses of 0.5 Sv (50 rem). And there is controversy over the Life Span Study rejection of the T65D type of dosimetry in favor of DS86 dosimetry, which underestimates the neutron contribution and leads to a much higher risk estimate. This suggests there are no significant excess deaths below a dose of 1 Sv (100 rem).

There is also no mention of important confounding factors for cancer incidence, such as the widespread, severe malnutrition, the pollution caused by the A-bomb blasts/fires; the psychological stress from burns, sickness, and loss of family members, friends, and homes; the loss of medical care, and so on.

Thus, the LNT model is not supported by any statistically significant evidence.[9] It should also be noted that there was no detectable increase in the incidence of mutations in the children or grandchildren of the A-bomb survivors.

The Nature of Cancer

Because fear of cancer is the issue, let us briefly examine the nature of cancer.[10] Cancer is a single disease and it is a hundred diseases. The unifying aspect of cancer is uncontrolled growth—the appearance of disorganized tissues that expand without limit, compromising the function of organs and threatening the life of the organism. Each cell type, each tissue, may spawn a distinct type of tumor with its own specific growth rate, prognosis, and treatability.

Virtually all malignant tumors are now thought to be monoclonal in origin; that is, the starting point for a tumor is a single abnormal cell, rather than a large group of normal cells being recruited by some agent into becoming cancer cells. Human tumors often become apparent only after they have grown to a size of 10 billion to 100 billion cells, in a person of 10 trillion to 100 trillion cells (cell weight is about 10^{-9} g).

Cancer is generally a disease of old people, because it usually takes a long time to accumulate the multiple mutations required to accelerate cell growth and disable growth suppression. To become a fatal tumor, a normal cell must undergo many changes—a long, complex series of successive changes in its behavior. Several decades must pass from the initiation of the tumor to its ultimate detection in the clinic.

The most disquieting fact about carcinomas is that they do not respect territorial boundaries. They grow locally and, eventually progressing further, shed small clumps of progeny cells able to start new colonies—so-called metastases—in other organs. These progeny cells travel through blood or lymph to lodge at distant sites.

Cancer cells evolve into a large number of diverse cells with new traits that allow them to grow more rapidly, compete more effectively with normal cells, and evade defenses. Tumor cell populations sooner or later exceed the ability of the host to nourish them. Often, long before that, tumors will compromise the functioning of a vital organ, leading to illness and then death.

The incidence of cancer increases exponentially with age, compatible with multistep, time-dependent tumor progression. For example, in the United States, the annual death rate from colon cancer rises from 14 to 83 to 400 per million, as people age from 40, to 60, to 80 years—a factor of ~6 and ~30. The risk increases approximately as the fifth power of elapsed time (Reference 10, p. 157).

What causes formation of abnormal cells or acceleration of the process leading to cancer? Many factors and carcinogens have been identified: genetics, diet, chemicals, biological agents, ionizing radiation, and so on. More are discovered every week, and the list appears endless. But recent research has revealed an immensely high rate of cell damage that is caused by normal metabolic activity as a result of attack by reactive oxygen species.[11]

Stimulation of Defenses

Living organisms have many defenses, both within and outside the cell, to prevent, repair, and remove cell damage.[11] These defenses can limit cell proliferation by signalling growth-factor rationing and growth-suppressor genes, and by other means. In addition to removing cells with persistent DNA damage, the immune system also plays an important role fighting certain types of cancers, especially if the

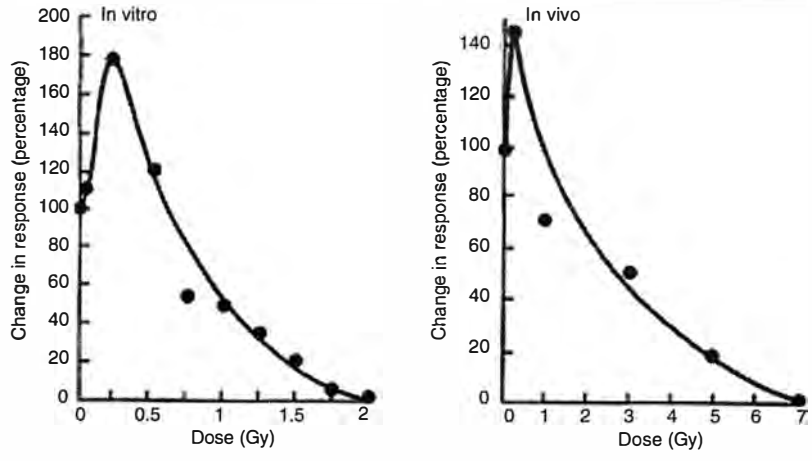


Figure 3
STIMULATION OF IMMUNE SYSTEM WITH RADIATION
Low-level radiation doses, such as a 10-fold increase in background radiation, stimulate prevention and repair of ongoing, natural DNA damage, in vitro and in vivo.
Source: Makinodan and James (Ref. 20)

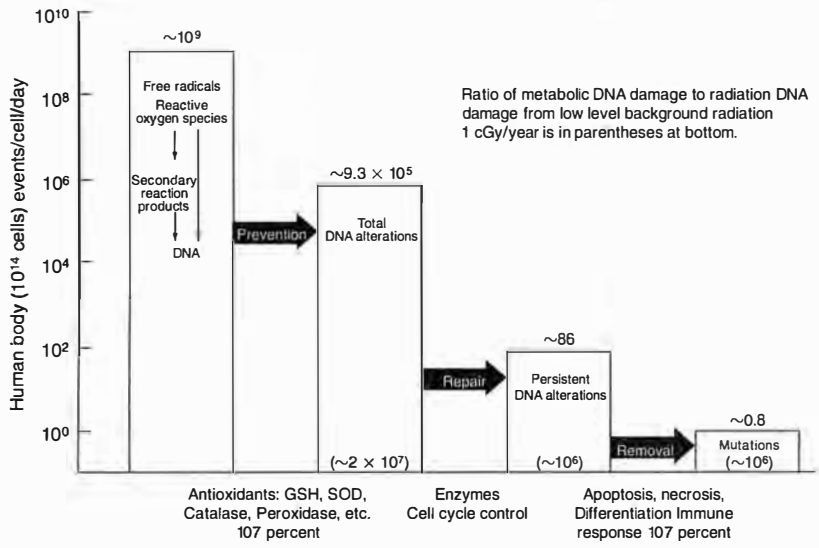


Figure 4
POTENTIAL EFFECT OF 1 cGy/YEAR BACKGROUND RADIATION ON RATE OF DNA MUTATION

Low-level radiation can decrease the gene mutation rate, thus decreasing mortality in general, and cancer mortality.

Source: Pollycove and Feinendegen (Ref. 11)

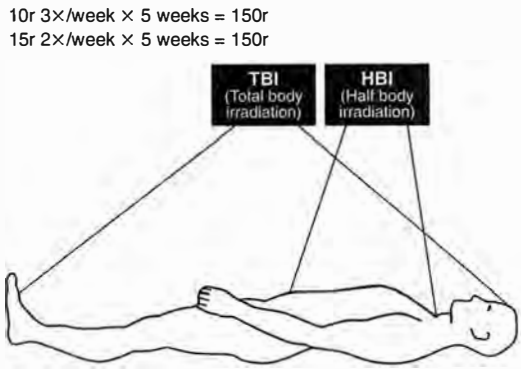


Figure 5
SCHEMATIC OF LOW-DOSE IRRADIATION THERAPY

Low dose irradiation therapy can be total body (TBI) or half body irradiation (HBI). Possible therapies are for 150 r, administered over five weeks, either three times a week at 10 r, or twice a week at 15 r.

immune system becomes stimulated.[11-13] Severe psychological stress, leading to depression and despair, adversely affects the defenses, creating hormonal imbalance and suppressing immune activity, allowing faster cancer progression.[14] As organisms age and mutations accumulate, their defense mechanisms become weaker and less effective in preventing new cancers and controlling the many cancers that have already started. For a long, healthy life, it is very important to maintain and enhance the performance of our natural defenses.

It was mentioned earlier that a large number of investigations were carried out over the past century into the effects of radiation on many different biological organisms, including plants. Many of these studies revealed significant beneficial health effects after exposures to low radiation doses. There is overwhelming evidence of this phenomenon,[15-20] and a model of the effect of ionizing radiation on living organisms has been provided by Pollycove and Feinendegen.[11]

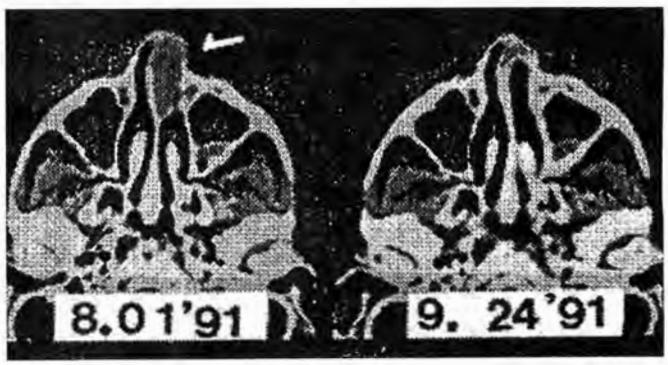
Recent studies show that low doses of radiation stimulate many cellular functions, including oxidation damage prevention, enzymatic repair, and immunologic and apoptotic removal of DNA damage (Figure 2). Acute, large doses (more than 50 cGy) impair these functions, causing adverse health effects. But chronic low doses, such as a 10-fold or even 100-fold increase in background radiation, stimulate prevention and repair of DNA damage and the immune system (Figure 3), which decreases the gene mutation rate (Figure 4), leading to the beneficial effects of decreased mortality in general and decreased cancer mortality specifically.

Therapeutic stimulation of these

Figure 6
SUPPRESSION OF CANCER IN UPPER NASAL CAVITY BY HALF-BODY LDI THERAPY

Research with mice, rats, and human beings has shown that low-dose body irradiation stimulates the immune system and prevents and removes cancer metastases, as shown here. Note the shrinkage of the tumor (see arrow) from August 1, 1991 (at left) to September 24, 1991 (right).

Source: Takai et al. (Ref. 21)



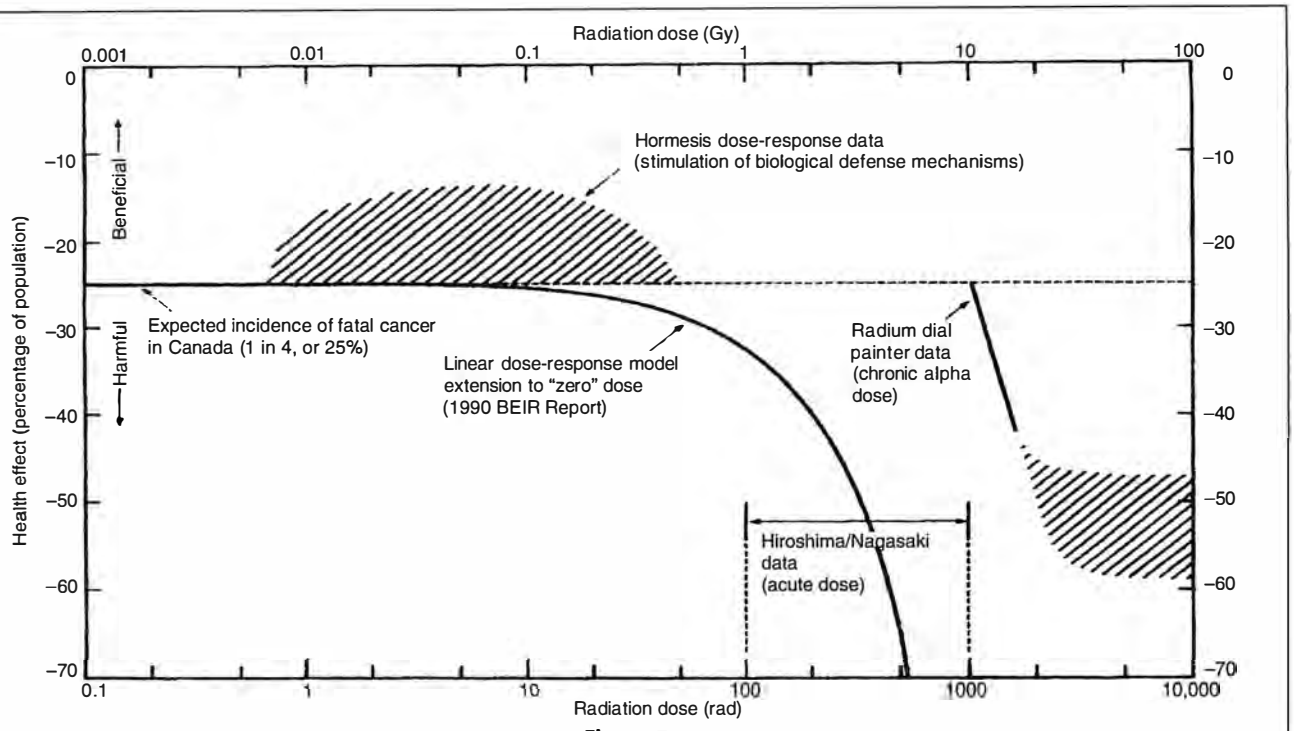


Figure 7
THE LINEAR MODEL WITH RADIATION DOSE ON A LOGARITHMIC SCALE

The beneficial effects of low-dose radiation can be seen in the hatched area above the dashed line, which marks the expected incidence of fatal cancers in Canada.

Source: Cuttler (Ref. 22)

defenses by low dose body irradiation (Figure 5) prevents and removes cancer metastases in mice, rats and humans (Figure 6).[21] The cell damage caused by the low dose radiation is insignificant compared to the metabolic oxidative DNA damage prevented, repaired, and removed by the stimulated defenses, leading to overall beneficial effects (Figure 7).[22]

Many medical studies have been carried out to determine the cancer risk after diagnostic and therapeutic treatments involving radiation, and there are very surprising results. The Canadian breast cancer study, published in 1989, compares breast cancer mortality with radiation dose, after fluoroscopic examinations for tuberculosis, between 1930 and 1952.[23] The plotted data from nine provinces (Figure 8) show a surprising decrease in risk at low doses (34 percent and 16 percent at the dose points of about 15 cGy and about 25 cGy).[24]

A recent study of hyperthyroidism treatment using radioiodine (at an average total dose of about 300 MBq, 50,000 cGy to the thyroid and 28 cGy

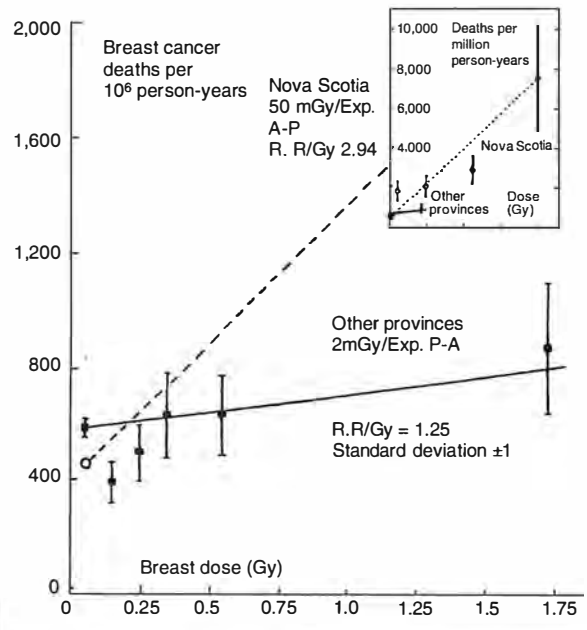


Figure 8
CANADIAN BREAST CANCER STUDY, AFTER FLUOROSCOPY EXAMINATIONS FOR TUBERCULOSIS

A Canadian study looked at breast cancer mortality rates of women who had fluoroscopic examinations for tuberculosis, between 1930 and 1952. The data from nine provinces show a surprising decrease in cancer for women who received low doses (34 percent and 16 percent at the dose points of approximately 15 and 25 centi-gray). The data show a reduction of 10,000 cancers in 1 million women who were actually exposed to 15 centi-gray, *instead of the linear conclusion that there would be 900 excess cancers expected at that dose.*

Source: Webster (Ref. 24)

Courtesy of the Denver Metro Convention and Visitor's Bureau

Residents of Denver typically get more background radiation, because of its higher altitude, than those who live in low-lying areas. The evidence indicates that there are health benefits from this radiation.

whole body) revealed a significantly lower cancer incidence and a lower cancer mortality.[25]

Japanese scientists, in fourteen universities and two research institutes, have been studying the beneficial effects of low radiation doses for 20 years, and they have found remarkable bio-positive effects,[18] including these:

- rejuvenation of cells (increase of SOD and cell membrane permeability)
- moderation of psychological stress through stimulation of key enzymes
- suppression of and therapy for adult diseases, such as diabetes and hypertension
- suppression of cancer through enhancement of the immune systems
- suppression of cancer and radio-adaptive response by activation of DNA repair and cell killing.

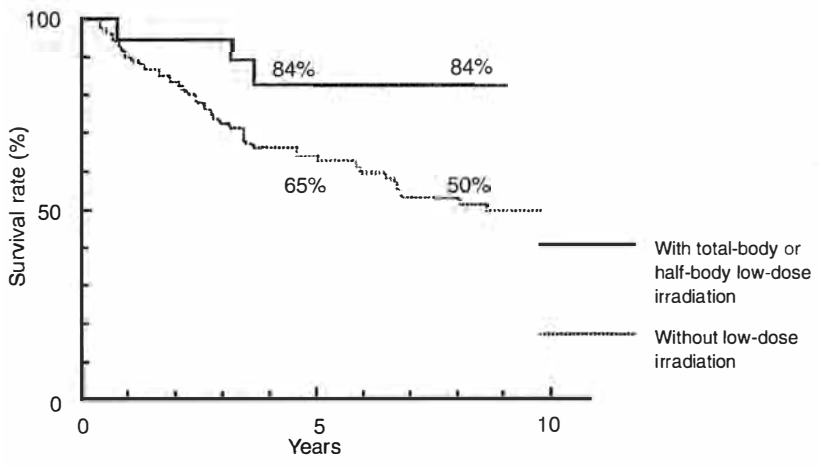


Figure 9
SURVIVAL RATES OF NON-HODGKIN'S LYMPHOMA PATIENTS WITH AND WITHOUT TOTAL- OR HALF-BODY LOW-DOSE IRRADIATION

These are the 9-year survival data reported by Sakamoto et al. of 23 low-dose radiation patients and 94 control patients with similar histological tumor grades. The survival rate of the low-dose radiation patients is 84 percent, compared with 50 percent survival of the control patients. The 12-year survival rate of the low-dose patients remains at 84 percent.

Source: Sakamoto et al. (Ref. 26)

Therapeutic Applications

One of these Japanese scientists, K. Sakamoto, provided total-body low-dose irradiation (LDI) therapy (using 6 MV X-rays) in conjunction with local, high-dose palliative radiation treatment to a patient with advanced ovarian cancer, after surgery. The LDI therapy, 15 fractionated doses of 10 cGy over a five-week period, achieved total elimination of the cancer metastases.

This success led to a program of LDI therapy for approximately 150 non-Hodgkin's lymphoma patients, including many intermediate and high-grade cases. This LDI therapy was given to patients who had previously received localized high-dose radiation and chemotherapy, and did not get better. Sakamoto found that the LDI enhanced their immune systems and other defenses, thereby achieving many cures, which have lasted more than 10 years.

Figure 9 shows that the recurrence-free survival rate of non-Hodgkin's lymphoma patients was increased by this therapy from about 50 percent to about 84 percent.[26] Despite these excellent survival rates, this controversial program ended recently when Dr. Sakamoto retired.

Similar effectiveness of the LDI therapy for non-Hodgkin's lymphoma had been noted at the Harvard Medical School in the 1970s, and more recently in France.[27] This success has led to the recent approval of a proposal for a clinical trial of LDI therapy in Europe.[28]

A comprehensive review of this application of low dose radiation therapy indicates that significant therapeutic benefits can be expected.[29] Nevertheless, oncologists seem to be very reluctant to use, or even consider, this therapy. For example, I note the current experiences of an American patient who has been requesting LDI therapy for a rare form of lymphoma (blood cancer). Only one oncologist, at the Johns Hopkins Medical Institute, was willing to provide this therapy. The patient's improvement observed after this treatment has been comparable to that achieved with chemotherapy, but with no symptomatic adverse side effects.[30]

Chernobyl and UNSCEAR 2000

April 26, 2001 was the 15th anniversary of the tragic Chernobyl accident, an accident that set off immediate, very strong reactions of fear and outrage throughout the world. Many people expected that the radioactivity released at Chernobyl would cause millions of cancer deaths and the birth of abnormal babies. The reality, however, is totally different.

The reality was documented in the 1,220-page *UNSCEAR 2000 Report: Sources and Effects of Ionizing Radiation,* that was released in June 2000[31] and tabled in September 2000 at the United Nations General Assembly. (UNSCEAR is the United Nations Scientific Committee on the Effects of Atomic Radiation.) It took the 146 committee members and staff from 21 countries, six years to collect and study the facts in 5,400 documents, in order to prepare the 20-page summary and 10 annexes of technical details.[32] This report is the most credible information on this subject, and was written by an independent, non-nuclear organization.

The UNSCEAR report compares the radiation dose that an average person receives from all types of natural and human-made sources. It estimates the health effects of this radiation, including those caused by the Chernobyl accident.

The average natural radiation dose is 2.4 mSv (0.24 rem) per year, but the report presents data (Figure 10) indicating that ambient radiation levels are many tens and hundreds times higher in some geographical regions where many people live. No adverse health effects related to radiation were ever observed among populations exposed to such high natural doses.

Human-made radiation sources expose the average person annually to much less radiation; for example, 0.4 mSv (0.04 rem) from medical diagnostics; 0.1 mSv (0.01 rem) from A-bomb tests in the 1960s; 0.05 mSv (5 millirem) from the Chernobyl accident; and less than 0.01 mSv (1 millirem) from nuclear electricity. Because radiation from natural or human-made sources affects living cells in the same way, we should not expect the health effects to be any different for those who receive the same dose from either source, in the short-term or the long-term.

Now, on Chernobyl: Of the 134 Chernobyl employees who developed symptoms of acute radiation disease, 28 died from radiation sickness and two died as a result of fire and falling objects—all the others with the symptoms of acute radiation disease recovered. Many emergency workers came to the station to remove radioactive debris, so as to allow the staff to continue operating the other three reactors. No

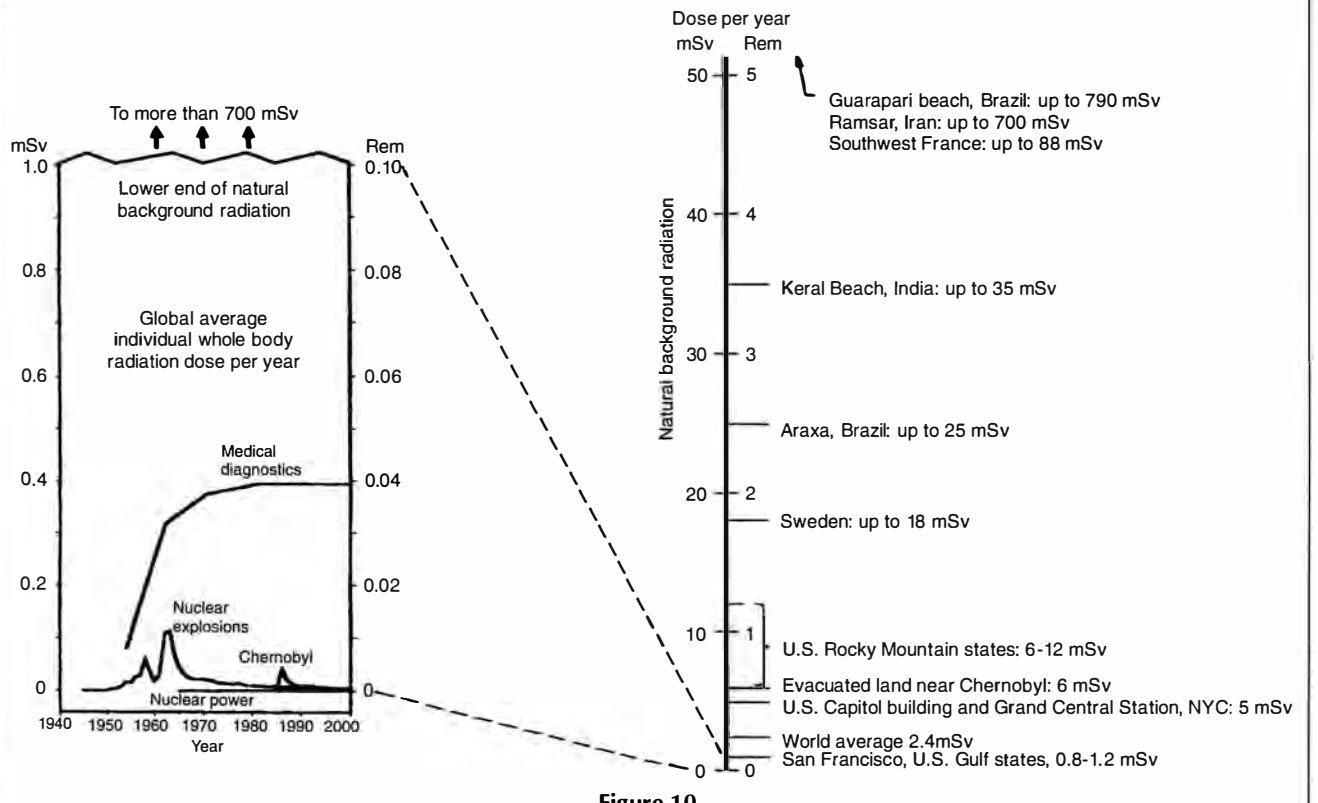


Figure 10

COMPARISON OF NATURAL AND HUMAN-MADE RADIATION, AVERAGE ANNUAL DOSE (1940-2000)

The average natural background radiation dose is 2.4mSv (0.24 rem) per year, but in many areas, the radiation levels are much higher, because of the altitude or mineral deposits in the soil. The human-made radiation dose to individuals per year is much smaller—for example, only 0.4 mSv (0.04 rem) from medical diagnostics.

Source: Rockwell (Ref.39); some data are adapted from Zbigniew Jaworowski's paper at the International Conference on Radiation, Teheran, Iran, Oct. 18-20, 2000, based on UNSCEAR figures

increases above the normal incidences of cancers or leukemias for the population as a whole were observed among these 381,000 clean-up workers.

The authorities moved 116,000 people from their homes in 1986, and 220,000 more later, in order to avert a lifetime (70-year) dose of more than 350 mSv (which is double the world's natural average background radiation), even though many people live very healthy lives in areas that are much more radioactive.

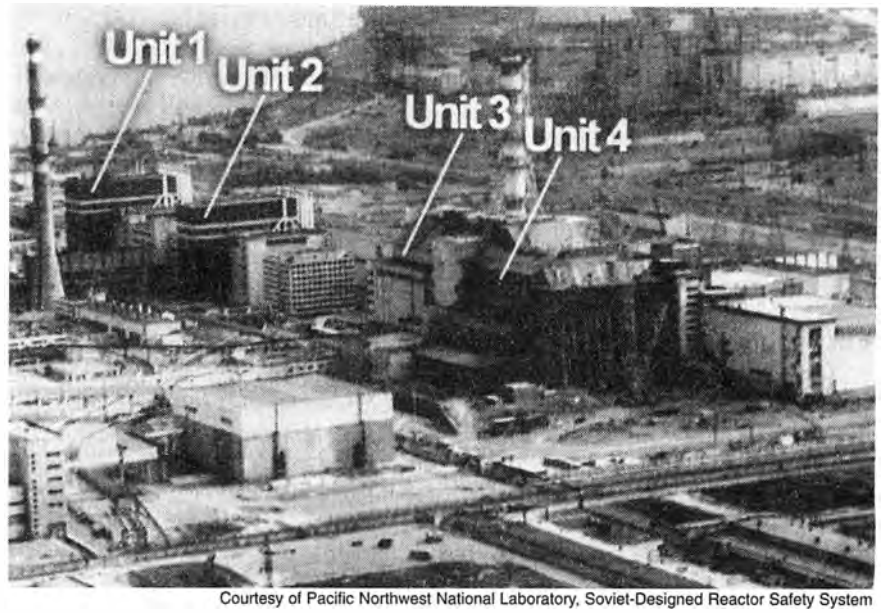
Careful health screening of all the people in the Chernobyl area began in 1986. Nothing like this thorough health program had existed before in the area. So far, this has identified a total of about 1,800 thyroid cancers. Before the accident, the incidence of thyroid cancers noticed in children was ~0.2 per 100,000 in Belarus and Ukraine; no data are available from Russia. The maximum incidence rates registered in 1987 to 1998 were as follows: Belarus 17.9, Ukraine 4.9 and Russia 26.6 per 100,000 children.

Does this mean that these cancers were caused by the accident? Normally, it takes 10 or more years for cancers to develop, if radiation is the cause, but half of these thyroid cases were found sooner than that (in Russia, for instance, in the second year after the accident, there were 9.1 cases per 100,000).

Also, the number of these thyroid cancers is *lower* in areas of higher dose! Could they be occult (small, stable) thyroid cancers? These happen naturally, and rarely cause medical problems.[33] Typically, there are many thousands of such thyroid cancers in a population of 100,000. The number varies according to geographic location, and depends on many different factors.

In the United States, there are 13,000 such cancers per 100,000 people (and 24,000 thyroid cancers per 100,000 in Hawaii). Is it therefore valid to conclude that there was an increase in thyroid cancer incidence after the Chernobyl accident, when there was no equivalent screening before the accident?

In a report of the U.S. National Council on Radiation Protection on thyroid cancer,[34] we have the remarkable statement that, "available human data on low dose I-131 [Iodine-131] exposures have not shown I-131 to be carcinogenic in the human thyroid." The National Cancer Institute carried out a 14-year study of thyroid cancers found all over the United States, in the 30-year period after the 100 A-bomb tests in Nevada, in the 1950s and early 1960s. The 1997 report compared the number in each area with the amount of radiation, and did not find any evidence to associate thyroid cancer to this radiation.[35-36]



Courtesy of Pacific Northwest National Laboratory, Soviet-Designed Reactor Safety System

The four 1,000-MW nuclear reactors at Chernobyl. Unit 4 is the damaged reactor.

So, it seems that the 1,800 "excess" thyroid cancers, in the Chernobyl screening, were *not* caused by radiation.

The UNSCEAR report concludes that no increases in cancer incidence or mortality have been observed that could be attributed to ionizing radiation; that the risk of leukemia does not appear to be elevated, even for the clean-up workers; and that there is no evidence of other non-malignant disorders that are related to radiation.

There were many psychological reactions to the accident, the UNSCEAR report states, but these were caused by fear of the radiation, not the actual radiation. In other words, there is no need for anyone to live in fear of serious health consequences from the Chernobyl accident. For the most part people were exposed to radiation levels comparable to, or only a few times higher than, the average natural background level.

Policies and Myths

Policies and myths that were created half a century ago by the International Commission on Radiation Protection (ICRP) have convinced many people that radiation is harmful in any amount. The regulatory authorities, and many research scientists, continue to ignore statistically significant evidence that contradicts this linear no-threshold view of radiation. They simply ignore both the evidence that shows there are no adverse effects from high levels of natural radiation in many regions, and the evidence that low doses of radiation received by nuclear workers and medical patients (including cancer patients) provide significant overall beneficial health effects.

The ethics of the International Commission on Radiation Protection's behavior is being questioned and debated in the scientific community,[37, 38] but there is enormous bureaucratic resistance to any change that would disturb the billions of dollars of research money and clean-up funding flowing as a result of the linear no-threshold myth.[40]

Most damaging is the public fear that this myth perpetuates, making it difficult for many scientists to present the real evidence of the beneficial effects of low-level radiation that have been observed on humans and other living things. It is, therefore, not surprising that the very important UNSCEAR 2000 Report received very little publicity.

So, the myths about cancer and abnormal babies will continue, as scientists carry out more and more politically

correct and politically funded research on the response of cells and mice to radiation.

The linear no-threshold myth blocks efforts to supply reliable, environmentally friendly nuclear energy, to power the world economies. It also blocks the widespread use of low-dose radiation therapy to cure or control cancer and other diseases. In the name of "protection," it is actually causing harm.

How long will it be before concerns about energy supplies and cancer death rates will cause people to pay attention to the actual scientific results, discount the myths, and take action to reap the great societal benefits?

Acknowledgements

I am grateful to Dr. Myron Pollycove, of the U.S. Nuclear Regulatory Commission and the University of California, San Francisco, for his comprehensive review of this paper. Also, Dr. Zbigniew Jaworowski, of the Central Laboratory for Radiological Protection in Warsaw, and Representative of Poland to UNSCEAR, provided valuable clarifications on the UNSCEAR 2000 Report and important information on thyroid cancer studies applicable to the Chernobyl accident.

References

1. S.R. Weart, 1988. *Nuclear Fear—A History of Images,* (Cambridge, Mass.: Harvard University Press).
2. R.H. Clarke, 2001. "Progress towards new recommendations from the International Commission on Radiological Protection," *Nuclear Energy,* Vol. 40, No. 1 (February), pp. 37-45 (Journal of the British Nuclear Energy Society).
3. R.D. Evans, 1974. "Radium in man," *Health Physics,* Vol. 27, pp. 497-510.
4. R.E. Rowland, 1994. *Radium in humans: A review of U.S. studies,* Argonne National Laboratory, DOE Report ANL/ER-3, UC-408.
5. M. Pollycove, L.E. Feinendegen, 1999. "Molecular biology, epidemiology, and the demise of the linear no-threshold (LNT) hypothesis." C.R. Acad Sci Paris, Sciences de la vie (Life Sciences), Vol. 332, pp. 197-204, Editions Elsevier, ISSN 0764-4469
6. R.E. Lapp, 1995. *My life with radiation—Hiroshima plus fifty years,* (Madison, Wisc.: Cognito Books), p. 67.
7. S. Kondo, 1993. *Health effects of low-level radiation,* (Madison, Wisc.: Medical Physics Publishing), p. 4.
8. D.A. Pierce, Y. Shimizu, D.L. Preston, M. Vaeth, and K. Mabuchi, 1996. "Studies of the mortality of atomic bomb survivors." Report 12, Part I. Cancer: 1950-1990, in *Radiation Research,* Vol. 146, pp. 1-27.
9. National Council on Radiation Protection and Measurement, 1995. *Principles and application of collective dose in radiation protection,* NCRP Report No. 121 (Bethesda, Md.), p. 45.
10. H. Varmus and R.A. Weinberg, 1993. *Genes and the Biology of Cancer* (New York: Scientific American Library, W.H. Freeman & Co.) p. 25.
11. M. Pollycove and L.E. Feinendegen, 2000. "Cellular and organism dose-response: biopositive (health benefit) effects," in *Proceedings of International Symposium on Health Benefits of Low-Dose Radiation—The Science and Medical Applications,* Washington, D.C., Nov. 15, 2000 (Needham, Mass.: Radiation, Science, and Health). http://cnts.wpi.edu/RSH/Docs/Pollycove2000 Symp_on_Med_Ben.htm
12. R.E.J. Mitchel and D.R. Boreham, 2000. "Radiation protection in the world of modern radiobiology: A time for a new approach," in *Proceedings of 10th International Congress of the International Radiation Protection Association, Hiroshima, Japan, May 2000,* Plenary Session 1. http://cnts.wpi.edu/RSH/Docs/IRPA10/Mitchel.html
13. L. Sompayrac, 1999. *How the immune system works* (Malden, Mass.: Blackwell Science Inc.).
14. O.C. Simonton, S. Matthews-Simonton, and J.L. Creighton, 1978. *Getting well again* (New York: Bantam Books).
15. T.D. Luckey, 1980. *Hormesis with ionizing radiation* (Boca Raton, Fla. CRC Press).
16. T.D. Luckey, 1991. *Radiation hormesis,* (Boca Raton, Fla. CRC Press).
17. United Nations Scientific Committee on the Effects of Atomic Radiation, 1994. *Adaptive responses to radiation in cells and organisms, Sources and Effects of Ionizing Radiation, UNSCEAR 1994 Report to the General Assembly, with Scientific Annexes.* Annex B.
18. S. Hattori, 1998. "The research on the health effects of low-level radiation in Japan," in *Proceedings of 11th Pacific Basin Nuclear Conference, Banff, Alberta* (Canadian Nuclear Society).
19. E.J. Calabrese and L.A. Baldwin, 1999. *Radiation hormesis: origins, history, scientific foundations* (Amherst, Mass.: University of Massachusetts, School of Public Health). http://www.belleonline.com/home82.html
20. T. Makinodan and S.J. James, 1990. "T cell potentiation by low dose ionizing radiation: Possible mechanisms," *Health Physics* Vol. 59, No. 1, pp. 29-34.
21. Y. Takai, S. Yamada, K. Nemoto, Y. Ogawa, Y. Kakutou, A. Hosi, and K. Sakamoto, 1992. "Anti-tumor effect of low dose total (or half) body irradiation and changes in the functional subset of peripheral blood lymphocytes in non-Hodgkin's lymphoma patients after TBI (HBI), Low Dose Irradiation and Biological Defense Mechanisms," Kyoto, July 12-16, 1992, in *Excerpta Medica,* Eds. T. Sugahara, L.A. Sagan, and T. Aoyama (Amsterdam: Elsevier Science Publishers), pp. 113-116.
22. J.M. Cuttler, 2000. "Resolving the controversy over beneficial effects of ionizing radiation," in *Proceedings of World Council of Nuclear Workers (WONUC) Symposium on the Effects of Low and Very Low Doses of Ionizing Radiation on Human Health, Versailles, France, June 17-18, 1999* (Amsterdam: Elsevier Science Publishers) pp. 463-471, AECL-12046.
23. A.B. Miller, G.R. Howe, G.J. Sherman , J.P. Lindsay, M.J. Yaffe, P.J. Dinner, H.A. Risch, and D.L. Preston, 1989. "Mortality from breast cancer after irradiation during fluoroscopic examination in patients being treated for tuberculosis," *N. Engl. J. Med.,* Vol. 321, pp. 1285-1289.
24. E.H. Webster, 1992. "Dose and risk in diagnostic radiology: how big? how little?" Lauriston S. Taylor Lectures in Radiation Protection and Measurements, Lecture No. 16, April 1992 (Bethesda, Md.: NCRPM), Fig. 12, p. 35.
25. J.A. Franklyn, P. Maisonneuve, M. Sheppard, J. Betteridge, and P. Boyle, 1999. "Cancer incidence and mortality after radioiodine treatment for hyperthyroidism: A population-based cohort study," *The Lancet,* Vol. 353 (June 19), pp 2111-2115.
26. K. Sakamoto, M. Myogin, Y. Hosoi, Y. Ogawa, K. Nemoto, Y. Takai, Y. Kakuto, S. Yamada, and M. Watabe, 1997. "Fundamental and clinical studies on cancer control with total or upper half body irradiation," *J. Jpn. Soc. Ther. Radiol. Oncol.,* Vol. 9, pp. 161-175.
27. P.M. Richaud, P. Soubeyran, H. Eghbali, B. Chacon, G. Marit, A. Broustet, B. Hoerni, 1998. "Place of low-dose total body irradiation in the treatment of localized follicular non-Hodgkin's lymphoma: Results of a pilot study," *Int. J. Radiat. Oncol. Biol. Phys.,* Vol. 40, pp. 387-390.
28. J.H. Meerwaldt and P. Richaud, 1999. "A phase III randomized study on low-dose total body irradiation and involved field radiotherapy in patients with localized, stage I and II, low grade non-Hodgkin's lymphoma," A proposal by EORTC Lymphoma Cooperative Group, 83, Avenue Emmanuel Mounier, Bte 11, B-1200 Brussels, Belgium, Sept. 13.
29. A. Safwat, 2000. "The role of low-dose total body irradiation in treatment of non-Hodgkin's lymphoma: A new look at an old method," *Radiother. and Oncol.,* Vol. 56, No. 1, pp. 1-8.
30. J.M. Cuttler, M. Pollycove, and J.S. Welsh, 2000. "Application of low doses of radiation for curing cancer," *Canadian Nuclear Society Bulletin,* Vol. 21, No. 2, pp. 45-46 (Aug.). http://cnts.wpi.edu/RSH/Docs/cuttler_et_al.htm
31. United Nations, 2000. "UNSCEAR Focuses on Chernobyl Accident in General Assembly Report," Press Release No: UNIS/UNSCEAR/1 (June 6). http://www.un.org/ha/chernobyl/unscear.htm
32. UNSCEAR, 2000. *Sources and Effects of Ionizing Radiation, The UNSCEAR 2000 Report—Summary,* http://www.cns-snc.ca/branches/Toronto/radiation/UNSCEAR2000Report.rtf
33. M. Moosa, E.L. Mazzaferri, 1997. "Occult Thyroid Carcinoma," *Cancer Journal,* Vol. 10, No. 4 (July-Aug.). http://www.fr.embnet.org/agora/journals/cancer/articles/10-4/moos.htm
34. National Council on Radiation Protection, 1985. *Induction of Thyroid Cancer by Ionizing Radiation,* NCRP Report No. 80, Chapter 4, "Human Experience after Exposure to Iodine-131."
35. R.A. Brown, 1997. *Bomb Fallout and Thyroid Cancer: Statistical Sheep in Real Wolves' Clothing.* http://www.srv.net/~russb/thyroid/index.html
36. National Cancer Institute, 1997. "NCI Releases Results of Nationwide Study of Radioactive Fallout from Nuclear Tests," Press Release, Aug. 1 (Bethesda, Md.: NCI). http://rex.nci.nih.gov/INTRFCE_GIFS/MASSMED_INTR_DOC.htm
37. Z. Jaworowski, 1999. "Radiation risk and ethics," *Phys. Today,* (Sept.), pp. 24-29
38. "Radiation risk and ethics: Health hazards, prevention costs and radiophobia," Letters in *Physics Today,* April 2000, p. 11 and May 2000, p. 11.
39. T. Rockwell, 2000. Personal communication, Dec. 5.
40. J. Muckerheide, 2000. "It's Time to Tell the Truth About the Health Benefits of Low-Dose Radiation," *21st Century,* (Winter), pp. 44-55. http://www.21stcenturysciencetech.com/articles/nuclear.html

Ancient Navigators Could Have Measured Longitude!

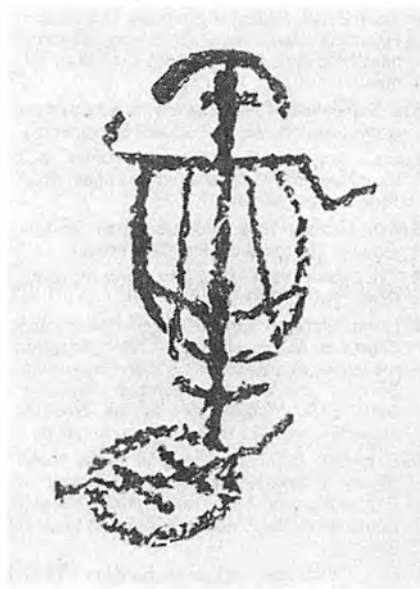
by Rick Sanders

Around the year 232 B.C., Captain Rata and Navigator Maui set out with a flotilla of ships from Egypt in an attempt to circumnavigate the Earth.[1] On the night of August 6-7, 2001, between the hours of 11 PM and 3 AM, this writer, and fellow amateur astronomer Bert Cooper, proved in principle that Captain Rata and Navigator Maui could have known and charted their location, by longitude, most of the time during that voyage.

The Maui expedition was under the guidance of Eratosthenes, the great scientist who was also the chief librarian of the library at Alexandria. Could this voyage have demonstrated Eratosthenes' theorem that the world was round, and measured approximately 24,500 miles in circumference? One of the navigational instruments which Maui had with him was a strange looking "calculator" that he called a *tanawa;* such an instrument was known, in 1492, as a *torquetum.*

Intrigued by a photograph of the cave drawing of that tanawa in Irian Jaya, western New Guinea, I speculated that Maui must have been looking at the ecliptic to measure "lunar distance," in order to find his longitude. Maui's tanawa was of such importance, that he drew it on the cave wall with the inscription, deciphered in the 1970s by epigrapher Barry Fell: "The Earth is tilted. Therefore, the signs of half of the ecliptic watch over the south, the other (half) rise in the ascendant. This is the calculator of Maui."

Eratosthenes had just measured the circumference of the Earth, and the circumference of a sphere is the same in all directions. We know that Maui was thinking about this, because his cave drawings also include a proof of Eratosthenes' experiment to measure the Earth's circumference.



From *America B.C.*, © Barry Fell (New York: Simon & Schuster, 1976), p. 118

Drawing by Maui of his tanawa or calculator, found in the Caves of the Navigators, Sosorra, Irian Jaya (West New Guinea).

To test the hypotheses, we built a wooden torquetum and used a simplified version of it to measure the change in angular distance between the Moon and the star Altair, in the constellation Aquila (the Eagle). This success proves official dogma wrong, and proves that, in principle, Navigator Maui, during his voyage could have used tables brought from Alexandria, drawn up by Eratosthenes or his collaborators, compared those lunar distances with the distances that he measured, and come up with a good estimate of his longitude.

It is important to note that we are not claiming here that we know everything about the torquetum. We simplified our device for the proof-of-principle experiment, but we will carry out and report on more experiments, using the full instrument.

The torquetum's value, as an analogue calculator, must have been immense, because, once a planet or the Moon are not on the meridian, all "straight lines" become curves—so that calculations are difficult, even with a modern calculator. However, the 23.5-degree plane on the torquetum allows one to directly read the longitude and latitude of a planet or the Moon, relative to the ecliptic, without calculation. These data would be invaluable for predicting eclipses and occultations of various stars or planets by the Moon.

The Inspiration for the Experiment

The inspiration for this experiment was twofold. On display at the 1992 Columbus Quincentennial exhibit in Washington, D.C., was a period torquetum. However, there was no description of how it was used, or what it was used for, and no one seemed to be able to give any explanation. I left that question fallow for a while, but then, thanks to a series of articles in *21st Century,*[1] I found that navigator Maui had a torquetum with him 2,200 years ago. Epigrapher Barry Fell's decipherments of the Maui-Rata expedition, including inscriptions found in Chile and Pitcairn Island, indicated that the fleet had reached the New World in 232 B.C. A sketch of the torquetum was found in the "Cave of the Navigators" in Irian Jaya (photographed by a German ethnologist Josef Röder in 1937); and from this, Dr. Sentiel Rommel, a U.S. marine biologist, built Fell a model of this tanawa (see graphic, p. 66, and *21st Century* Spring 1999, p. 77).

This was intriguing! What was this "tanawa" for? Why the 23.5-degree plane, characteristic of the torquetum? It could only mean that Maui was looking

at the ecliptic, the Moon, and the planets, the "wandering stars."

Of the two torquetums surviving in the world, one belonged to Nicholas of Cusa, and the other to Regiomontanus, both of whom were involved in calendar reform, including setting the date of Easter, which, along with some other religious festivals, is dated by the interaction of the lunar and solar calendars.

But what could Maui have been doing? Trying to determine longitude? The very thought was heretical. To take things out of the realm of speculation, the only solution was to build a torquetum, and see if longitude could be determined by using sightings of the Moon, with simple backyard equipment; if this succeeded, then Navigator Maui could have also succeeded.

Finding Longitude

Longitude is hard to find. The ancients used eclipses for determining longitude, but these are too infrequent to be of much use for navigation. You can't just look at a star (like Polaris), as is done for finding latitude. The textbooks say that to determine longitude from shipboard, requires a chronometer, or a special sextant mounted with a telescope; or a telescope capable of detecting the occultation of the moons of Jupiter—technologies that were not perfected until the 18th Century.

You cannot tell longitude from the stars alone, because their daily motion is purely apparent, caused by the rotation of the Earth. At 8 PM (solar apparent time), any star, seen from anywhere, whether Ferrara, Paris, or Cairo, will have the same azimuth as it does in Washington, D.C., Chicago, Sioux Falls, S.D., Seattle, or anywhere else. The Moon shares in this apparent motion to the west, but it also has its own independent, real motion.

Look at what Amerigo Vespucci, himself at the frontiers of post-Dark-Ages navigational astronomy, said of this in 1502, in Letter IV:

". . . I maintain that I learned [my longitude] . . . by the eclipses and conjunctions of the Moon with the planets; and I have lost many nights of sleep in reconciling my calculations with the precepts of those sages who have devised the manuals and written of the movements, conjunctions, aspects, and eclipses of the two luminaries and of the wandering stars, such as the wise King Don Alfonso in his Tables, Johannes Regiomontanus in his Almanac, and Blanchinus, and the Rabbi Zacuto in his almanac, which is perpetual; and these were composed in different meridians: King Don Alfonso's book in the meridian of Toledo, and Johannes Regiomontanus's in that of Ferrara, and the other two in that of Salamanca."[2]

The best "clock" to use for reference, is the stars. In the roughly 27.3 solar days of a lunar orbit, the Moon moves a full 360 degrees around the sky, returning to its old position among the stars. This is 13 degrees per day, or just over 0.5 degree per hour. So, while the

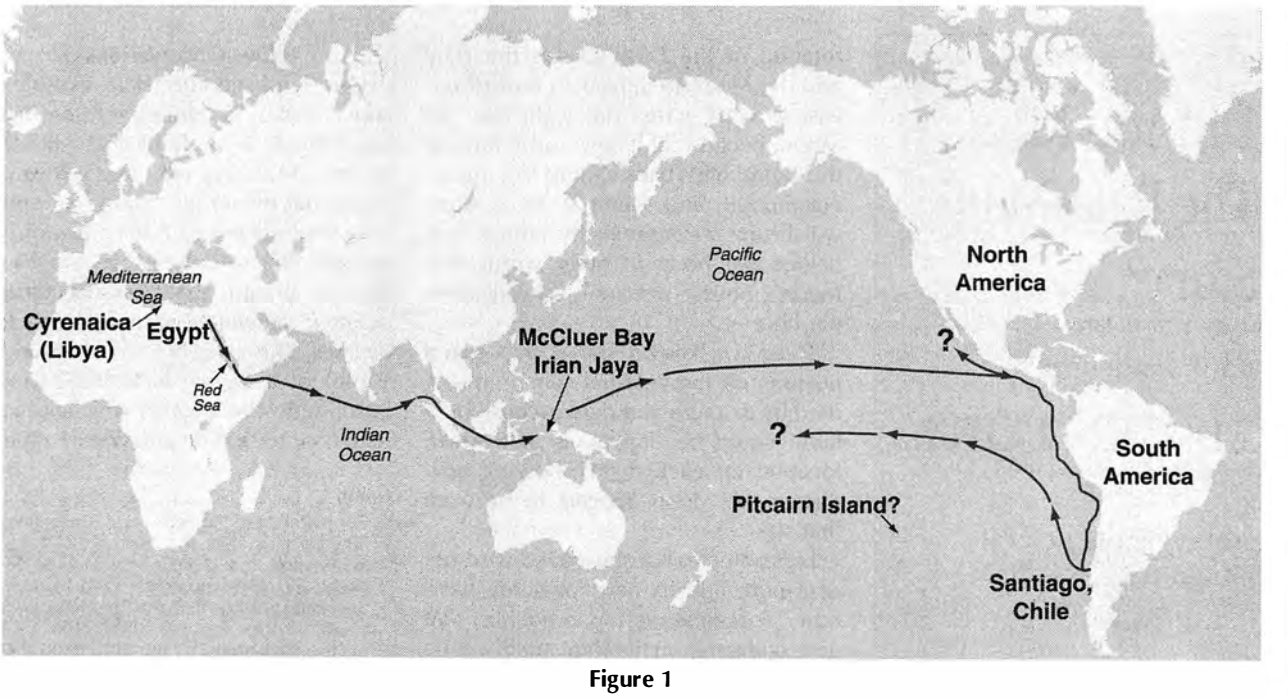


Figure 1
PROBABLE ROUTE OF THE EGYPTIAN VOYAGE IN 232 B.C.

Deciphered rock and cave inscriptions from the Pacific islands, western New Guinea, and Santiago, Chile, tell of an Egyptian flotilla that set sail around 232 B.C., during the reign of Ptolemy III, on a mission to circumnavigate the globe. The six ships sailed under the direction of Captain Rata and Navigator Maui, a friend of the astronomer Eratosthenes (ca. 275-194 B.C.), who headed the famous library at Alexandria. Maui's inscriptions, as deciphered in the 1970s by epigrapher Barry Fell, indicated that this was a proof-of-principle voyage, to demonstrate Eratosthenes' theorem that the world was round, and approximately 24,500 miles in circumference.

A brass model of Maui's tanawa, constructed by Dr. Sentiel Rommel. The base (A) in the plane of the observer's horizon, is oriented so that the axis of symmetry is parallel to the meridian. (B) is the equatorial plane. (C) is the ecliptic plane (viewed from one side in Maui's drawing, hence appearing as a line).

Drawing by Matt Makowski in *The Epigraphic Society Occasional Publications*, Vol. 32, No. 29, Feb. 1975

The author, using an equatorial sundial to establish a north-south line.

rotation of the Earth causes the stars and the Moon to appear to move from east to west across the night sky, the Moon, because of its own orbit around the Earth, fights back against this apparent motion, and seems to move eastward (or retrograde) by about 0.5 degree per hour. In other words, the Moon "moves" west only 11.5 degrees per hour.

Thus, if a known star is in a given position on the celestial sphere (measured by azimuth and right ascension), a table could be drawn up at a given location for each night, showing how distant the Moon appears to be from that star.

For example: If a ship sailed west out of a port, and its new longitude were now 15 degrees west (one hour) of that port, and those on the ship could see the Moon and the reference star, the Moon would appear to be 0.5 degree east of where the table would show it to be for the port of departure. There is nothing here that navigator Maui in 232 B.C. could not have known. The only question would be whether his instruments could measure an angular difference on the order of 0.5 degree.

Our Observations

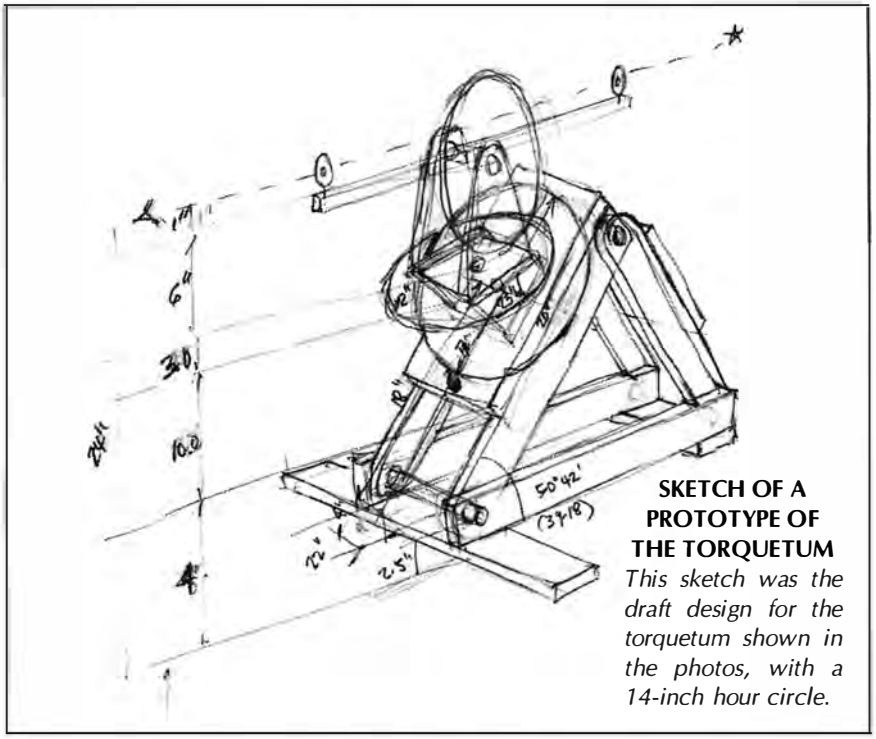
Our observational experiment showed that a simplified torquetum could do it. In the time that Altair had moved 41.8 degrees west along the equatorial plane, the Moon had moved only 40.25 degrees, a difference of 1.55 degrees. Because the Moon should retrograde about 0.5 degree/hour, the *calculated* regression would equal 1.39 degrees. This error of less than 1/6th (or 0.166) of a degree is well within our instrument limitations, which can be read only to 0.25 of a degree.

Notes

1. For the story of the Rata-Maui Expedition, see "The Decipherment and Discovery of a Voyage to America in 232 B.C.," by Marjorie Mazel Hecht, *21st Century,* Winter 1998-1999, p. 62; "Indian Inscriptions from the Cordilleras in Chile" found by Karl Stolp in 1885, *21st Century,* Winter 1998-1999, p. 66; "On Eratosthenes, Maui's Voyage of Discovery, and Reviving the Principle of Discovery Today," by Lyndon H. LaRouche, Jr., *21st Century,* Spring 1999, p. 24; "Eratosthenes' Instruments Guided Maui's 3rd Century B.C. Voyage," by Marjorie Mazel Hecht, *21st Century,* Spring 1999, p. 74; and "Maui's Tanawa: A Torquetum of 232 B.C.," by Sentiel Rommel, Ph.D., *21st Century,* Spring 1999, p. 75.
2. Cited in *Letters From A New World,* 1992. Ed. Luciano Formisano (New York: Marsilio Publishers), pp. 38-39.

Building and Using Maui's *Tanawa*

by Bertram Cooper



SKETCH OF A PROTOTYPE OF THE TORQUETUM
This sketch was the draft design for the torquetum shown in the photos, with a 14-inch hour circle.

These photos show the assembly of a primitive wooden torquetum (a model of Maui's *tanawa*), in preparation for celestial observations. Obviously, the torquetum was photographed during daylight hours, but a primary use of the instrument would be for stellar and planetary observations, and measurements of the Moon's motion.

The instrument's "lower unit" is raised up, from its horizontal frame to the angle of the co-latitude of the observer (90 degrees minus latitude), such that the polar axis of the hour circle will be parallel with the polar axis for the rotation of the Earth.

The direction of the polar axis can be established by first laying out a good south line at the planned point of observation, so as to provide a local "anchor" from which to measure time across the sky.

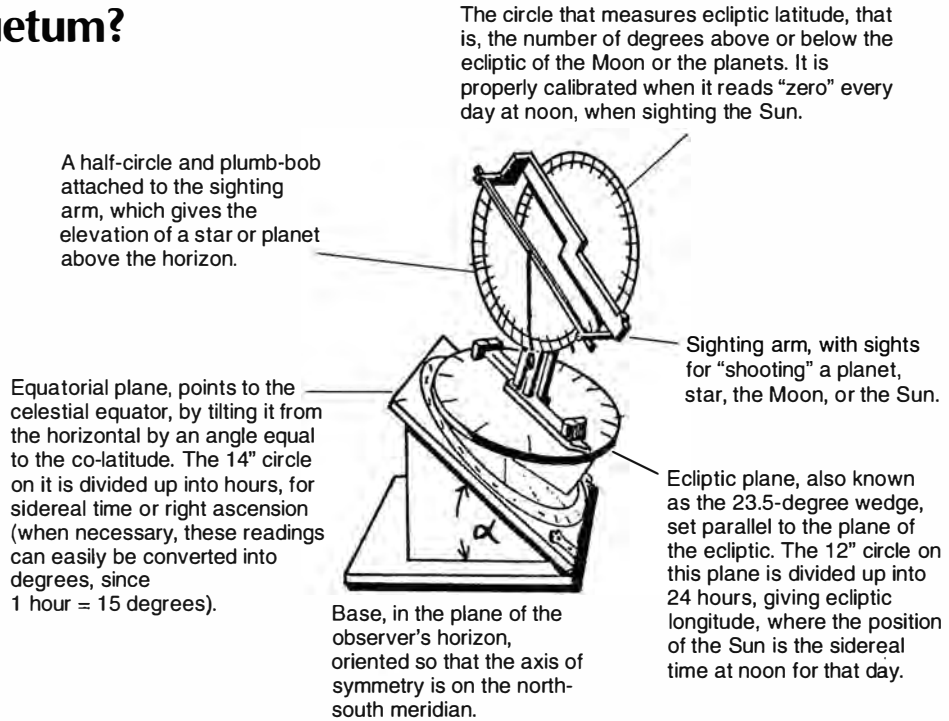
Polar north can be determined over the course of a 12-hour *or longer* night, to a high degree of precision, by locat-

What Is a Torquetum?

The torquetum, an analogue computer, can tell us, without long and tedious calculation, at any time of the night when planets or the Moon are visible, what their angular distance is from the Sun, or from the first point of Aries, and/or from some bright star in their vicinity. It can also tell us how much they are above or below the ecliptic.

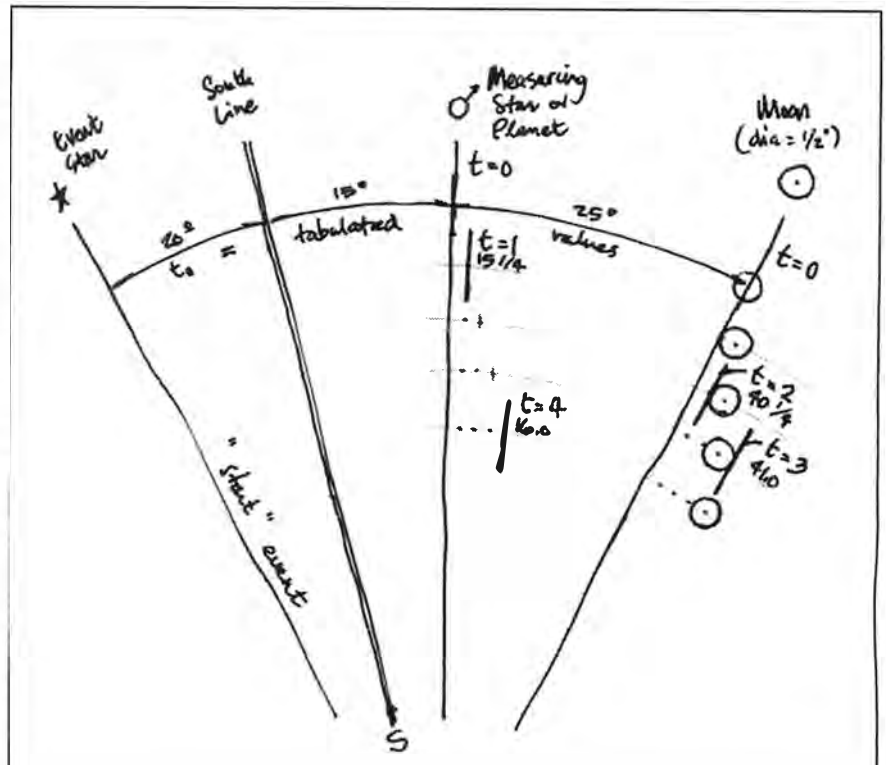
This would give us a fairly quick way to construct an almanac, with enough data to predict at least lunar eclipses, as well as occultations of bright stars or planets by the Moon—the which dramatic events ought to confirm the longitude readings obtained by using the torquetum to measure lunar distance.

—Rick Sanders



Source: Adapted from Sentiel Rommel, "Maui's Tanawa: A Torquetum of 232 B.C.," *21st Century*, Spring 1999, p. 75.

01



A POSSIBLE METHOD OF SIGHTING

This is a study for a possible method of sighting. Each reading would consist of a "set" of two readings on a measuring star or planet, and two readings on the Moon, one on the trailing edge and one on the leading edge, resulting in an average at the center. It was found to be more accurate to align the edge of the Moon against the crosshair, rather than trying to guess exactly where the center of the Moon was for each shot. Figuring that a minute of time passes between each alignment, the four shots would then be averaged, to compute the angular separation of the Moon at the required moment of first action.

Note that a sequence of four shots, paced evenly at about one minute per shot, which is a natural and adequately unhurried pace, such as Maui might have used, minimizes the error. This sequence is (1) one on the reference star, (2) one on the trailing edge of the Moon, (3) one on the leading edge of the Moon, and (4) one again on the reference star, which, when reduced, produces the instantaneous angle at the tabulated trigger event.

On his voyages, Maui would have probably carried with him tables prepared by Eratosthenes in Alexandria, and using those as a reference point, he would make his own tables, based on his findings of local longitudes.

—Bert Cooper

ing the eastern and western elongation of any bright circumpolar star, and then *splitting* the difference. This can be supplemented with daytime observations of the Sun at noon, if you can find noon.

Given the present location of the vernal equinox, the north star is not true north, but is within three quarters of a degree of polar north. Sights can be made to accurately shoot astronomical north, and to establish a true north-south line for the setup.

Here (Photo 1), the sights are installed for a polar sighting and alignment, by a groove cut into the endplate of the lower unit. It must be noted that Maui was travelling approximately 2,200 years ago, and our present pole star was, at that time, farther from the position of the celestial pole. However, Maui would have found true astronomical north to be somewhere near the midpoint between Beta Ursa Minoris, and Polaris.

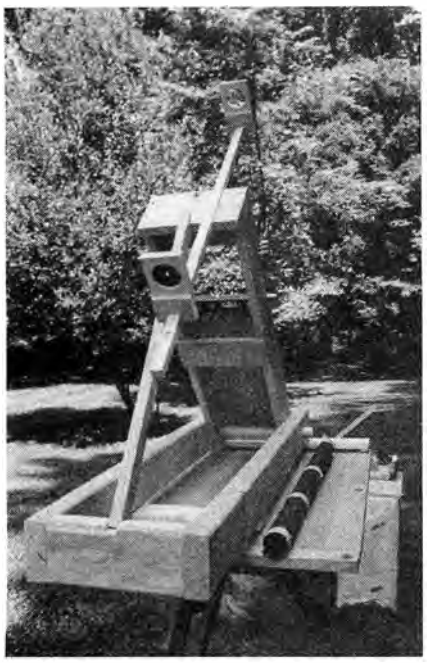
Another view of the setup (Photo 2), shows the frame of the instrument, parallel to the Earth's axis, and parallel to an instrument circle to be placed on the frame, which will give the right ascension along the celestial equator.

This setup is one in which the sights would be used at night for a polar alignment of the frame. Unlike the arrangement for daytime use, here the crosshairs are put as a front sight, and the rear sight is a 1/4 " diameter hole, like the peep sight on a rifle.

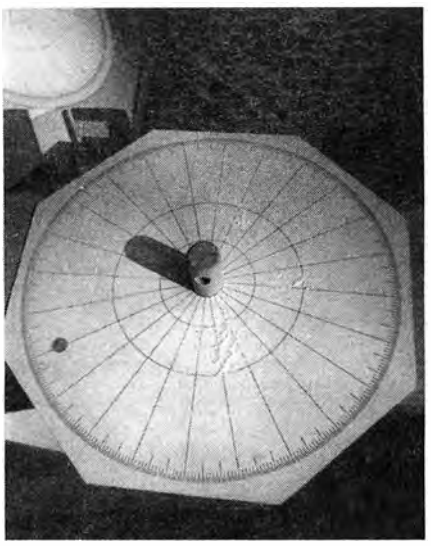
The yoke with its wooden bearings now awaits assembly. It is awkward to set up the circles and bearings with the instrument in place, so this was done at a separate work table. The notched crosspiece in the yoke will ultimately support the sights. In the middle, a 23.5-degree wedge was made to imitate the inclination of the Earth's axis relative to the plane of the solar system. This circle must be set daily for the Sun's position on the ecliptic.

The Equatorial Circle

The 14-inch equatorial circle (Photo 3) takes a fair amount of time to con-



02



03

struct, and easily competes with truing-up bearings in terms of patience and the extended concentration required for success. It is constructed with compass and dividers, first dividing the circle into sixths, producing six 60-degree lines; and then dividing each sixth by one-half, and then one-half again, producing twenty-four 15-degree (or one-hour) lines.

Using dividers, each hour is then divided into thirds, producing three 20 minute lines at 5-degrees each; each of these is then divided into fifths, to produce five 1-degree lines (4 minutes). Each degree is then divided into halves, producing one-half degree lines.

It is extremely important that the instrument move smoothly. We do not know what substance Maui used, but we used talcum powder to lubricate the movement of the circle with its adjoining surface, the bottom of the 23.5-degree wedge of obliquity. Dried clay from a river bed would work just as well.

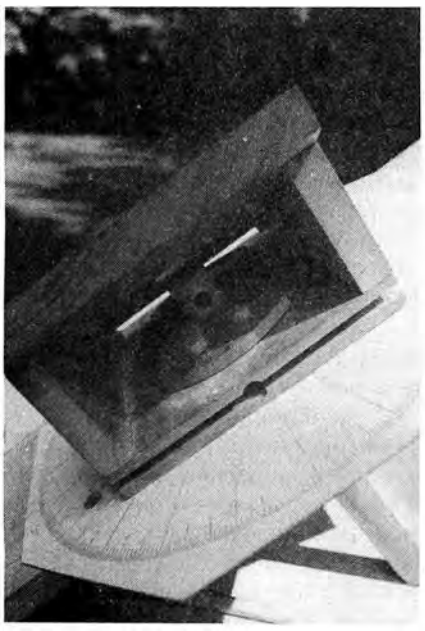
After the 14-inch equatorial circle has been installed on the instrument's polar axis, the 23.5-degree wedge is installed, with its main bearing (Photo 4). Talc is provided here too, so that the wedge, with yoke and sights installed, will turn smoothly on the fixed wooden bearing and hour circle. Any jerky movement of the sights against the hour circle will prohibit accurate readings of the stars later on.

The main bearing, which controls tension in the rotation of the sighting bar against the equatorial circle, is controlled by a compression of matted material such as horsehair; we used the underlining for a rug. A keeper bar is inserted to hold things in place temporarily. The bearing for the yoke and sighting bar is then installed into the upper plate of the 23.5-degree wedge, with its keeper bar.

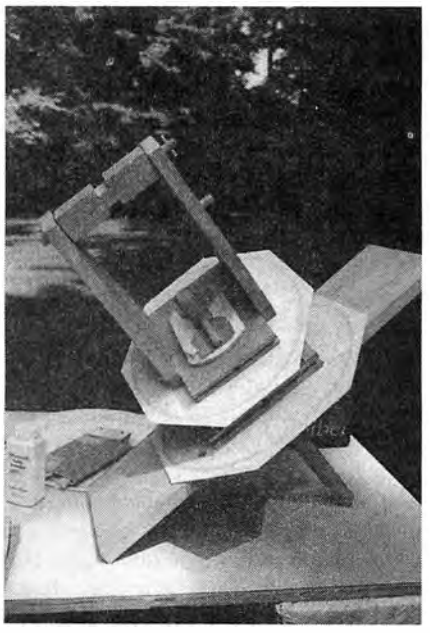
The Annual Circle

A 12-inch annual circle, marking degrees longitude from the vernal equinox, is then mounted, on the upper bearing, along with the sighting bar yoke (Photos 5 and 6). This is held in firm compression by paper wedges. There is no need for smooth motion on this bearing, as it is set only once for each day or evening, and does not change during an observation session.

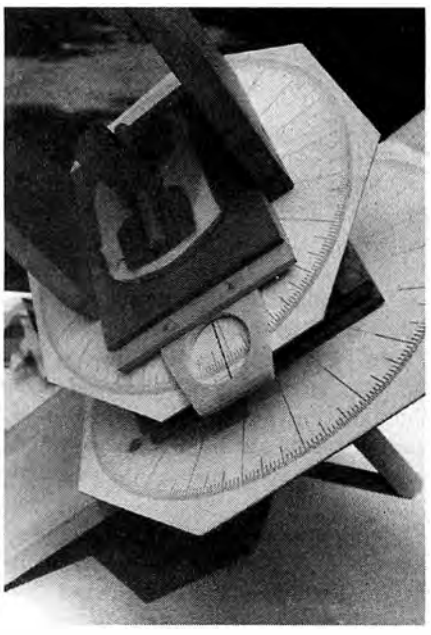
The vertical circle, marked off to 1/2 a degree, is then installed, which, when mounted on the annual circle, will give a direct reading (without calculation) of



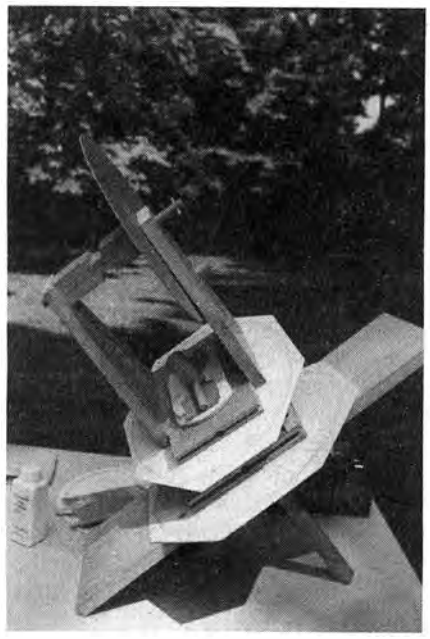
04



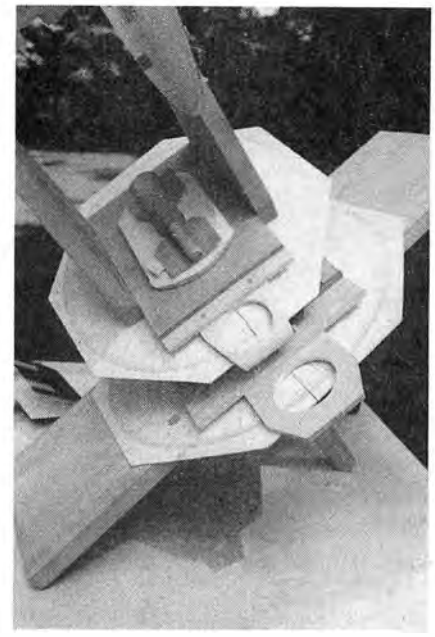
05



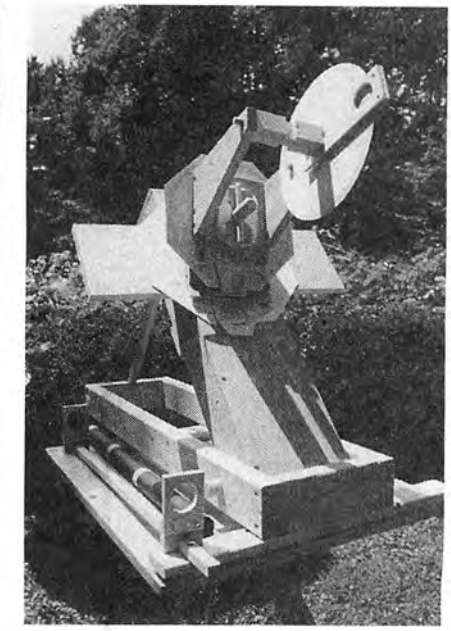
06



07



08



09

10

the celestial latitude of the planets and the Moon, above or below the ecliptic (Photo 7). When mounted directly on the hour circle, without the wedge of obliquity, this circle will give a direct reading of the declination of celestial objects, above or below the celestial equator.

Then the index mark for the declination circle—a piece of thread, held in place with glue—is installed; and the index mark for the 12" annual circle is installed (Photo 8).

This completes the assembly of the instrument, which is now ready for mounting into its lower unit, as shown in Photo 9. It may seem that we are ready to mount the sighting bar and its sights; but first, we have to provide tension for compression on the "horsehair" of the main bearing, for smooth motion of the hour circle.

A lower plate, with crossbar and compression wedges is provided, to put the 14-inch equatorial circle in mild compression, removing as much play as possible between it and the lower plate of the 23.5-degree wedge, while still at the same time providing smooth motion.

Then, the sighting bar with sights is mounted (Photo 10).

Various sighting systems were investigated. The best results so far, for daytime solar observations, were a front sight consisting of a 1/4-inch hole in a piece of hardboard. The middle "sight" is a crosshair, which is used for alignment of the Sun's image. This crosshair consists of two threads, which are glued in place. The rear "sight" is a sheet of paper, which catches the image of the Sun (through the aperture of the 1/4-inch front sight) with the crosshair superimposed (Photo 11).

For nighttime observations, there are only two sights used: with the crosshairs becoming the front sight, and the hardboard with the quarter inch hole becoming the rear sight. A surveyor's technique proved useful: When sighting, keep both eyes open and the mind focussed and concentrated only upon the celestial object—not upon the sight or the crosshair.

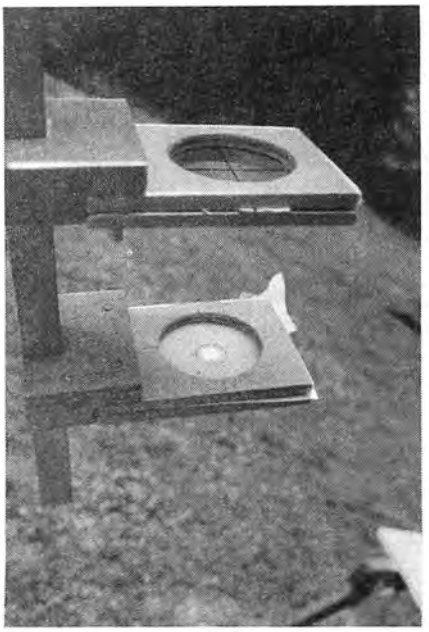
A sighting on the Sun is then collimated by two separate motions (Photo 12). For a right-handed person, the vertical motion of the sighting bar is controlled by the right hand, and is moved up and down only as required.

The horizontal motion of the instrument is controlled by the turning bar, held in the left hand, which is braced by the cross. Under no circumstances should torque be applied to the sighting bar. When crosshairs are visible and in focus, the image of the Sun can be captured easily to an accuracy of a quarter of a degree, or a minute of time, or less (Photo 11).

Photo 13 shows a view of the east side of the torquetum. The longitudinal position of the Sun along the ecliptic affects the adjustment of the entire instrument.

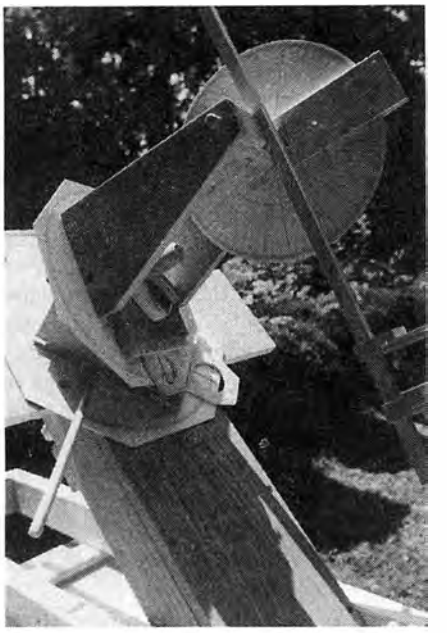
Proof of Principle

For our first "proof-of-principle" experimental observations of the motion of the Moon, in order to determine longitude on Earth, our measurements were done with a "stripped down" torquetum, without the 23.5-degree wedge installed. This minimal torquetum had only the 14" equatorial circle, pointing



11

12



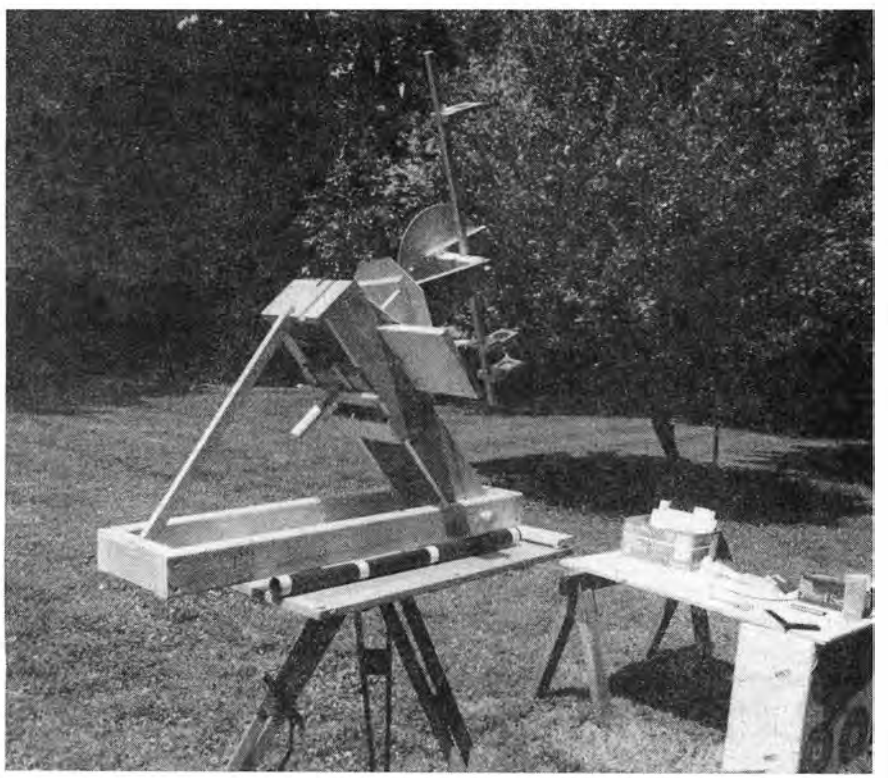
13

to the celestial equator, which directly measured a sidereal angle along the celestial sphere, known as lunar distance.

A view from the east (Photo 14) shows the completed torquetum, equipped with solar sights, in a setup ready for the recording of observations.

With our torquetum assembled, we can now start gathering a wealth of data, particularly the declination of the Sun at noon, and the equation of time (by contrasting our digital watches with the Sun's arrival on the south line every day). The notorious equation of time, caused by the apparent "speeding up" and "slowing down" of the Sun, will force us to reflect on the fact that the solar system does not allow itself to be forced into arbitrary circles with uniform motions.

For example, why do the equations of time make two peaks and two valleys during the course of the year (see table), while declination has only one peak and one valley during the year? Why are the equations of time not zero at the equinoxes? Why are the number of days between the seasons not equal?



14

EQUATIONS OF TIME

Here are the equations of time, in minutes, for certain singular events, taken from the almanac data for longitude zero for years 1990 and 1991:

March 21,	+7.24 equinox
April 16,	0.00
May 14,	+3.71 peak
June 14,	0.00
June 22,	–1.90 solstice
July 25,	–6.50 valley
Sept. 02,	0.00
Sept. 24,	+7.90 equinox
Nov. 03,	+16.42 peak
Dec. 22,	+1.50 solstice
Dec. 26,	0.00
Feb. 11,	–14.24 valley

Source: Prepared from data in the *Astronomical Almanac* of 1990 and 1991

Hot Air Over Wind Energy

by Greg Murphy

Near-bankrupt U.S. farmers are being sold a bill of goods by the Department of Energy about how they should rent (or lease) their land to be used as "wind farms," where "high tech" windmill turbines will allegedly make them money by selling electricity to the power grid. In fact, the only way wind power can make money, is with huge government subsidies, tax breaks, and phony accounting.

Here's what the wind-power windbags are doing, and why it won't work:

The push for "alternative energy sources" goes back to the post-John F. Kennedy paradigm shift, when the anti-industrial elites decided to shift America from an agro-industrial economy to a post-industrial service society. The wide-scale promotion of anti-technology ecologism—and fears about the most efficient available energy source, nuclear power—were part of that game plan. This insanity mushroomed during Jimmy Carter's Administration, and has been getting worse ever since.

To increase the use and development of wind energy and other renewable sources, the Clinton Administration modified its proposed Federal utility restructuring legislation, mandating an increase in the percentage of electricity produced by renewable sources from 2 percent today, to 7.5 percent by the year 2010. (Sen. James Jeffords (I-Vt.), has proposed to increase the percentage of electricity produced by wind to 20 percent.)

In 1999, Energy Secretary Bill Richardson announced the Wind Powering America Initiative, which set the goal of producing 80,000 megawatts of electricity from wind power by the year 2020.

To help make wind power more competitive, the Federal government provides a 1.5-cents per kilowatt-hour (kwh) Production Tax Credit for all electricity generated by new wind plants for the first 10 years of their operation. This Production Tax Credit will expire on Dec. 31, 2001, and the American Wind Energy Association is currently lobbying Congress to extend the tax credit for at least five more years.

Mike Hodgkiss/EIRNS

Still not profitable, even with subsidies and efficiency improvements. Here, a windfarm near Livermore, Calif.

Several states are pushing for legislation, known as Renewable Portfolio Standards (RPS), which mandates that a certain percentage of electrical power come from so-called renewable sources, like wind power, and that these wind percentages increase year after year. Some of the states are giving tax incentives or rebates for the purchase of small wind turbines, as in the case of California, which currently offers a tax rebate of up to 50 percent of the purchase price of the wind turbine.

Phony Cost Accounting

The truth that the wind energy windbags don't want to tell the public, is the real cost of production of wind power! They claim it is now about 3 to 6 cents per kilowatt hour—not quite competitive with other sources, but in the ballpark. In truth, even with government subsidies, tax breaks, and phony accounting, the cost is many times this claim.

In the 1980s, the cost of generating wind power was about *38 cents per kwh,* according to the November 1998 Renewable Energy Policy Program report, titled "Expanding Wind Energy: Can Americans Afford It?" There have been improvements in efficiency of wind turbines, which were the result of

materials and design research in the aerospace industry. However, these improvements have been nowhere near enough to drop the wind generation cost to the level being claimed. The 3 to 6 cents per kwh claimed by the industry for wind power is not a true cost, but an accounting fiction, called a *levelized cost*.

Technically, the levelized cost of energy, is the cost in current dollars of all fuel, capital, and operating and maintenance expenses during the lifetime of the power plant, divided by the estimated output in kilowatt-hours over the lifetime of the power plant. In the case of a wind farm, there is no cost for fuel, but the wind turbine is dependent on nature to provide the necessary wind. The problem with considering the levelized cost in the case of wind energy, is that this cost is figured on the assumption of a *constant maximum wind* for a given area.

In other words, levelized cost assumes a constant wind, every day for 20 to 30 years! There is no place on the Earth that the wind blows at a constant maximum average speed all the time.

Further, these calculations are dishonest about the maintenance cost of wind turbines, keeping them unrealistically low. They figure for a wind farm, which might consist of 100 to 250 windmills, a maintenance crew of three men and a truck. They also assume a yearly repair cost at a ridiculously low total of about $750 a year.

In reality, wind turbines have considerable down time for repairs and cleaning. One recent study found that flying insects—such as bees, locusts, gnats, and butterflies—cut the efficiency of turbines by as much as 25 percent. Thousands of insects fly into the turbine blades and die, forming a ragged crust on the blades leading edge. Even a millimeter of this crust generates drag that can ruin the turbine's efficiency.

Another consideration is the power transmission cost. Even if, after the 1.5 cents Federal subsidy, windmills could sell electricity at 6 cents per kwh, the power still has to move along the transmission grid to the consumer. Because wind power is an intermittent power source, rates for access to the transmission grid are higher. To counter this, the American Wind Energy Association is lobbying for what they call "fair access" to the transmission grid.

Windmill power will never be competitive with more modern forms of energy production. For one thing, the same improvements in technology that might make the wind turbine more efficient would also improve the efficiency of turbines turned by coal, oil, gas, and nuclear. But, even if technological improvement could miraculously make the cost of wind power competitive with modern forms such as nuclear, would we want it?

Wind Fails Energy Density Test

The fact is that there is a more important factor than cost-in-the-small to be considered in evaluating an energy source. If you look at the overall demands for electrical energy and industrial process heat in a growing industrial economy, wind energy could never begin to provide even a tiny percentage of what is needed.

First, you must look at the concentration of energy per area of work, which is shown as watts per square centimeter, and as power output in kwh per square kilometer of land area. Next, you look at what levels of energy flux density will foster the increase of the population density. The energy density of wind is intrinsically too low to maintain the population at current levels, and will lead to population decrease over time—which is exactly what the Malthusian environmentalist movement wants to accomplish.

In order for all mankind to progress, we have to develop sources of energy with higher flux density, and develop the technology that can make use of these sources.

A version of this article appeared in The New Federalist *weekly newspaper.*

The Meaning of Dolly

by Colin M. Lowry

The Second Creation: Dolly and the Age of Biological Control
Ian Wilmut, Keith Campbell, and Colin Tudge
Cambridge, Mass.: Harvard University Press, 2000
Paperback, 333 pp., $16.95

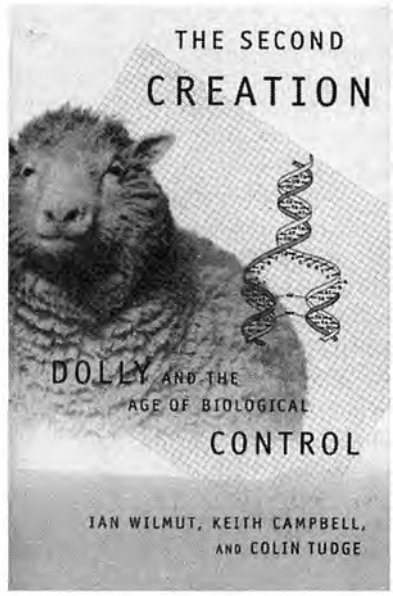
The cloning of the now-famous ewe Dolly, reported in 1997 by Ian Wilmut, Keith Campbell, and a team of scientists from Scotland, has overthrown many dogmas in science and hinted at the possibilities to come from this technology. In this book, Drs. Wilmut and Campbell tell the story of their research, with the intention of introducing nonspecialists to the intricacies of embryonic development, genetic engineering, and the historical development of ideas in biology.

Neither of these two scientists started his research with the cloning of mammals as the goal. In fact, cloning was used merely as a more efficient way to genetically engineer animals. The driving force behind their work was to find a way to produce therapeutically useful human proteins in agricultural animals, such as blood clotting factors to treat hemophilia, or enzymes to treat cystic fibrosis.

Human cloning was, and still is, something both these scientists are opposed to, and their discussion of what a genomic clone is, and is not, will likely burst the illusions of many people whose knowledge on the subject comes from the popular press.

The genetic determinist view, which derives from the legacy of Nazi eugenics, is ridiculed through the authors' discussion of what makes an individual actually an individual. Wilmut and Campbell cloned four lambs from the same DNA, and according to the genetic determinist view, all these lambs should be the same. But, they are all different in size, weight, demeanor, and behavior! It is the environment during the development of an animal that is the most important, not the genes.

Much media hype surrounded the possibility of human cloning, with fears of creating clones of Hitler. The authors explain that even a clone of Hitler,



would never become a ruthless dictator, as the cloned person would develop and grow in an entirely different set of circumstances, and would become a different individual. Cloning cannot replicate individuals as such, it can only create DNA clones.

Perhaps the most exciting thing to happen from the cloning research was that it shattered several dogmas in biology, most important, the old rule that differentiation of a cell was like going down a dead-end street, with no chance of ever regaining the potential to develop into any cell type in the body. Dolly, cloned from the nucleus of an adult cell in culture, proves that the genome of a differentiated cell can be "reprogrammed" to produce an entire new individual, restoring the totipotency of the cell.

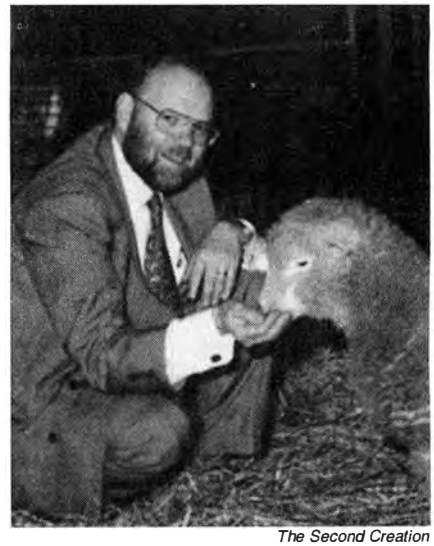
This has profound implications for the study of genetic regulation and the debate on stem cell research. Because we know it is possible to regain totipotency, if we can discover how the environment of the oocyte activates the genome, we may be able to direct development in cells toward specific cell types, or toward stem cells of pluripotency. From this perspective, in the future, it may be possible to reproduce any damaged tissue or cell type from a person's own cells.

The Road to Dolly

The question of when and how the cells of an embryo start to lose their totipotency has puzzled biologists for more than a century. The authors review some of the important experimental milestones in embryology of the 20th century, starting with the first documented cloning of an animal by Hans Driesch. Just after 1900, Driesch separated the cells from sea urchin embryos at the two- and four-cell stages. Each of the cells grew into an entirely new animal, showing that the embryonic cells retained totipotency, at least at this stage.

In the 1930s, Hans Spemann provided the first experiment that demonstrated the principle that factors in the cytoplasm may hold the key to totipotency. Spemann tied a loop around a single-cell salamander embryo, such that one side contained the nucleus, and the other only cytoplasm. However, the isolated nucleus continues to divide.

After four rounds of division, Spemann allowed a single nucleus to migrate back into the other cytoplasmic chamber by loosening the loop. Once returned to this cytoplasm, the nucleus from the 16-cell



The Second Creation

Ian Wilmut with Dolly.

stage reverted, and formed an entirely new embryo. Spemann then proposed a "fantastical" experiment in 1938, to replace the nucleus of an oocyte with one from a differentiated adult cell. He could not carry out the experiment, however, because the techniques required did not exist at that time.

In 1951, the transfer of a cell nucleus into an egg was successfully done using frogs. The nuclei were removed from frog embryos at the late blastula stage, when the frog embryo is a large ball of several thousand cells. Thomas King and Robert Briggs did the experiments to investigate whether genes are actually lost during development and differentiation of cells, or just switched off.

The results of the King and Briggs experiments produced embryos that survived to the tadpole stage. It seemed that the genes were not lost, but that they may have been inactivated, some perhaps permanently. By the early 1960s, completely normal adult frogs had been cloned by nuclear transfer from tadpole nuclei. However, understanding and manipulating the egg of a mammal to produce clones remained a mystery.

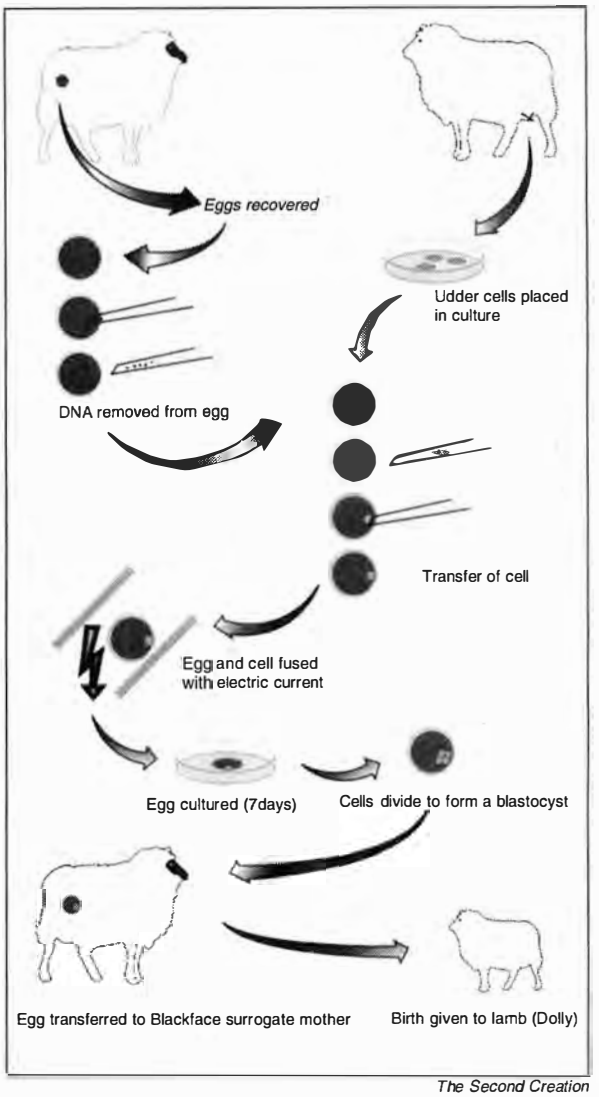
Amphibian eggs are thousands of times larger than those of mammals, and amphibian eggs are also very tough; they can handle manipulation by experimenters, because they are designed to grow and survive in an external aqueous environment. Working with mammals was much more delicate, and it was not until 1985, that the first mammal was cloned by a nuclear transfer from early embryo cells.

Ian Wilmut was trained in embryology and reproductive biology, and had been working at Roslin Institute since 1973. In 1982, the direction of his research shifted to genetic engineering of livestock, specifically sheep. Genetic engineering of mice, using the technique of microinjection of DNA into the nuclei of embryonic stem cells, was being developed at this time, and Dr. Wilmut first pursued this same approach in sheep. The problem was, that embryonic stem cells from sheep could not be kept in culture in such a way that would prevent them from differentiating. This rendered them unusable.

It would be so much easier, he thought, to use fetal or adult cell lines, and use the more standard techniques for introducing DNA into cell cultures. Then one could just select the cells that incorporated the genes one wanted to introduce, and create a new animal by nuclear transfer into an oocyte. The problem was that the prevailing view in biology before 1985, was that it was impossible to clone mammals by nuclear transfer.

Many scientists believed this for two reasons: The first, has to do with what is called genomic imprinting. The genes from the male and female parents carried in the sperm and egg, are different in activity. Experiments in mammalian zygotes (the fertilized egg), in which the zygote was artificially given two sets of chromosomes from the female parent, and none from the male, or vice versa, resulted in an embryo that would become malformed and die in the late blastocyst stage.

The second reason for the belief was that, after a short number of cell divisions in most mammals, the continued growth of the embryo requires the zygotic genome to become activated and start producing proteins. This timing varies among species, and the most studied mammal at that time was the mouse, whose zygotic genome is quickly activated, just after the first cell division. This means that there is very little time for a genome introduced by nuclear transfer to be correctly remodelled and activated.



The Second Creation

Schematic of the cloning procedure used for creating Dolly.

In 1985, Steen Willadsen reported he had successfully cloned several sheep using nuclei transferred from 16-cell embryos into oocytes. This was a stunning achievement, and one that influenced Ian Wilmut strongly. In 1989, Wilmut was part of the team at Roslin that cloned four lambs in a method much like that used by Willadsen. Three donor nuclei came from 16-cell embryos, and one from a blastocyst cell that had already activated its zygotic genome.

The question remained whether it was possible to use even older and more differentiated cells as nuclear donors for cloning, which would facilitate a whole new way to genetically engineer animals. It was becoming clear to Dr. Wilmut that the point in the cell cycle of the donor cell had an important influence on the success of the cloning. It was at this point that Roslin Institute brought in Dr. Keith Campbell in 1991, whose research had focussed on cell-cycle regulation and cancer.

Dr. Campbell's Insight

Dr. Campbell provided what turned out to be one of the key insights about the cell cycle, which contributed to the successful cloning of Dolly.

The cell cycle is how cells grow, replicate their DNA, and ultimately divide in the process of mitosis. However, cells that differentiate drop out of this routine, and go into a state known as G0, or quiescence, when almost all RNA and protein synthesis is shut down. This quiescent state is a prerequisite for the process of differentiation, and it may be that the genome in this state is more accessible to "reprogramming."

The procedure used in the cloning of Dolly put the cells in culture into this quiescent G0 state, before their nuclei were removed. Actually, Dolly was not the first sheep cloned at Roslin by this method. In 1995, two sheep, Megan and Morag, were cloned from nuclei taken from embryonic fibroblast cells. Dolly created more of a sensation, because she was cloned from the nucleus taken from an adult udder cell.

Later in 1997, the first genetically engineered cloned sheep, Polly, was born, but little attention was paid to this event by the general press. Polly is perhaps the fullest expression of the work Ian Wilmut and Keith Campbell set out to do. Polly carries the human genes for blood clotting factor IX, which she secretes in her milk.

Despite the many dire predictions that cloned animals would be defective, Dolly is perfectly healthy, and has already had three lambs of her own. She does, however, have one difference found so far with her chromosomes. She has shorter telomeres than would a normal sheep her age. (Telomeres are the ends of the chromosomes that are used up each time the cell divides and the DNA is replicated.) Because she was cloned from a cell that came from a six-year-old ewe, you could think of her as being a four-year-old sheep with a ten-year-old's telomeres. So far, this has had no effect on her health, but time will tell if it shortens her lifespan to any degree.

A Valuable Account

Reading this book as a biologist, I found it to be a detailed and valuable account of the developments leading up to the cloning of Dolly. However, the organization of the book interferes with the flow of the story. Each author has written sections of the book, and these often jump around in the sequence of how and when things were done, or they repeat in a different way what was covered in a previous section. This would have been hard to follow if I were not already familiar with the work, and it would be easy to get lost in the details of the experiments, and miss the importance of many of the discoveries.

The authors of the book contend that the cloning of Dolly and her successor, Polly, may have more impact on biology in the 21st Century than any other discovery of the 20th Century. This work has now shown the way to producing in animals any human protein for which the genetic sequence is known, or perhaps even any tissue needed to repair damage in patients.

This ability is very important, because therapeutic proteins are becoming more difficult to purify from blood and serum, as a result of the risks of HIV and the presence of other viruses in the population. Genetically engineered cloned animals could rapidly produce all the therapeutic proteins medicine requires in the very near future.

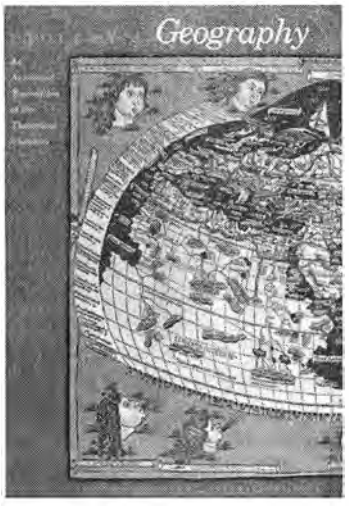
From the continued research on the connection between genomic remodelling in the zygote, and the process of differentiation, we may gain the knowledge needed to direct the development of cells into any type we choose. This would give us the understanding needed to re-grow a person's own tissue to repair damage, and may also lead to new insights into treating cancer.

There are dozens of ways the cloning and genetic engineering of animals will benefit medicine. Perhaps animals with human tissue and immune marker genes may be produced in the future that will be suitable for transplantation of organs into human patients. There is a dire shortage of available organs for transplant worldwide, and approximately 25,000 people die each year before a transplant organ becomes available. Also, genetically engineered animals could be used as models of human disease, and cures could be initially developed and tested in animals.

This is an interesting book on an important topic, and if the reader has the patience to get through the disorganized flow of the story, it is certainly worthwhile reading for those who want to understand the changes in science and medicine that Dolly has brought about.

The Fraud of Ptolemy—Ignored

Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters
J. Lennart Berggren and Alexander Jones
Princeton: Princeton University Press, 2001
Hardcover, 192 pp., $39.50



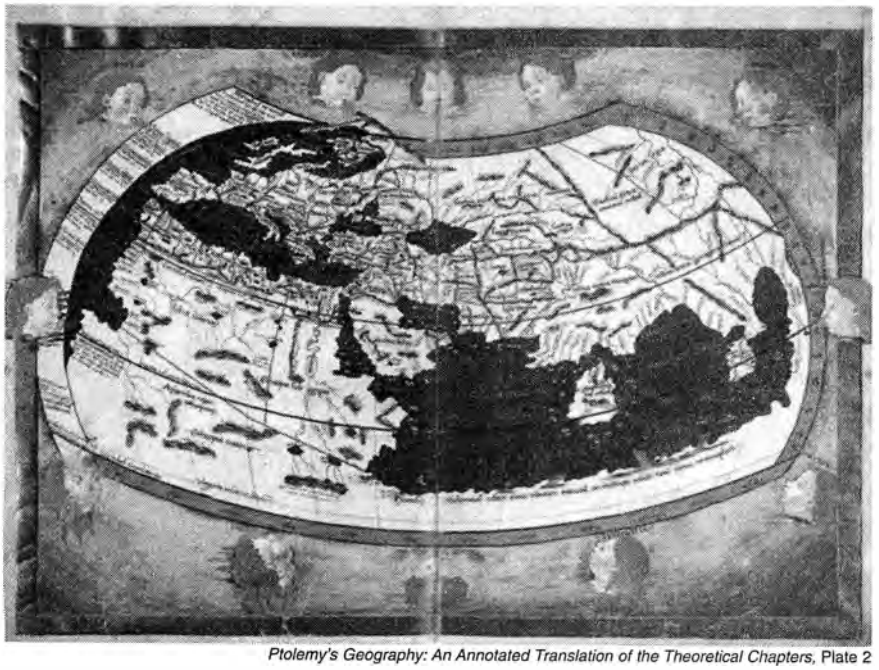
I kept falling asleep trying to read this book, and then I figured out why. Whatever valuable "information" might be in it, the entire thing is a fallacy of composition, because it ignores the crucial starting point of any work on Ptolemy: How did he get to be one of the world's most successful liars? Why did he do so? How did the rest of us get bamboozled for a millennium and a half into believing such palpable lies?

One example: Ptolemy's famous map from the 2nd Century A.D. (Plate 2), shows the Indian Ocean landlocked; hence Africa could not be circumnavigated. Yet, the ancients knew this to be false. Hipparchus (2nd Century B.C.) talks about the Egyptian Pharaoh, Necho II, who sent an expedition to circumnavigate Africa, which did so successfully. And both the world map of Eratosthenes (3rd Century B.C.) and the map of Strabo (63 B.C.?), show Africa circumnavigable.

It was the Renaissance's Toscanelli, by-passing the Ptolemaic fabric of lies, who went back to the ancients, and provided geographical documents to both the Portuguese and the Spanish; the former chose to to "go east" by rounding Africa, while Columbus chose to "go east" by going west.

The two authors of this book belong firmly in the same camp as Ptolemy: they are camp followers of Zeus, and sworn enemies of Prometheus.

—Rick Sanders



Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters, Plate 2

Ptolemy's map from the 2nd Century A.D., shows the Indian Ocean landlocked with no passage around Africa possible, ignoring what had been known about world geography for centuries before.

For Young Readers

Boing-Boing the Bionic Cat and the Jewel Thief
Larry L. Hench
Westerville, Ohio: The American Ceramic Society, 2001
Hardcover, 68 pp., $17.00, Ages 7-11

This is the second book about Boing-Boing, a bionic cat created by a bio-engineering professor for his young neighbor, who longed for a pet cat, but was allergic to real ones. Boing-Boing walks and purrs, but because of a programming error, he says "boing-boing," instead of miow. In this book, Professor George has programmed the cat's tail to roar when pulled.

Boing-Boing and his owner, Daniel, visit the local Natural History Museum, where Daniel accidentally leaves his cat sitting next to a lion, in a room full of stuffed big cats of the jungle. During the night, Boing-Boing cleverly nabs a museum burglar, who inadvertantly steps on his tail while trying to sneak out.

The illustrations are charming, the story is engaging, and I hope that there will be more Boing-Boing books from the author. It's also time for the publisher, the American Ceramic Society, to get to work producing some bionic cats for sale, or at least some bionic cat kits.

Marie Curie: Courageous Pioneer in the Study of Radioactivity
Beverley Birch
Woodbridge, Conn.: Blackbirch Press, Inc., 2000
Hardcover, 64 pp., $19.95, Ages 10-13

This substantial biography is part of a "Giants of Science" series published by Blackbirch, and first published 10 years ago in England under the title of "Scientists Who Have Changed the World." It tells the story of Marie Curie well, presenting the personal history, the science, and the politics in a way that gives a sense of who Madame Curie was, and how she approached scientific problems.

The author avoids tedious political correctness, and merely notes in the Afterword: "The development of nuclear power may be the most controversial development to derive from Marie Curie's original work. . . . Today, the

biggest challenge that remains is to make the correct use of the technology that Marie Curie inspired."

Unlike most children's "science" books today, this one is beautifully put together, with many excellent and unusual photos. It does not have the characteristic dizzying composite illustrations that are geared to the presumed short attention span of the young reader (or perhaps to the short attention span of the illustrator).

I would hope that young readers would be inspired to go on and read about Curie in the lengthier biography written by Marie's daughter Eve (which I count as one of the most memorable books I've ever read).

Thomas Edison: The World's Greatest Inventor
Anna Sproule
Woodbridge, Conn.: Blackbirch Press, Inc., 2000
Hardcover, 64 pp., $19.95, Ages 10-13

This introductory biography of Thomas Edison, another book in the "Giants of Science" series, gives the reader a good sense of the power of science and technology, and the role of creative individuals. As the author writes about Edison, "He did not merely change the world he was living in. His inventions helped to bring a totally different world into existence—the one we are living in today."

Biography is an important way of transmitting culture and giving younger generations a broader understanding of history. It is difficult to reduce a scientific life (or any public life, for that matter) to 64 pages. In this case, there is a good overview of his life, but I wish there had been more scientific detail about Edison's discoveries, and some ideas from his notebooks about what he was thinking.

Another omission, is of the tremendous political faction fight Edison was involved with, against the Wall Street financial interests, who put profits above the nation's general welfare.

Nevertheless, this nicely illustrated book is bound to capture the imagination of young readers, and inspire at least some of them to further investigate Edison and his experiments.

—Marjorie Mazel Hecht

Books Received

Lessons from the Living Cell: The Limits of Reductionism, Stephen Rothman. New York, McGraw-Hill, 2001. Paperback, 240 pp., $24.95

Why Animal Experimentation Matters: The Use of Animals in Medical Research, Ellen Frankel Paul and Jeffrey Paul, eds. New Brunswick, N.J.: Transaction Publishers, 2001. Hardcover, 224 pp., $49.95

Mission Jupiter: The Spectacular Journey of the Galileo Space Probe, Daniel Fischer. New York: Copernicus Books, 2001. Hardcover, 317 pp., $32.00

Visions of Spaceflight: Images from the Ordway Collection, Frederick I. Ordway III. New York: Four Walls Eight Windows, 2001. Hardcover, 176 pp., $50

Junk Science Judo: Self Defense Against Health Scares & Scams, Steven J. Milloy. Washington, D.C.: Cato Institute, 2001. Hardcover, 218 pp., $18.95

The Age of Science: What Scientists Learned in the Twentieth Century, Gerard Piel. New York: Basic Books, 2001. Hardcover, 400 pp., $40

Clouds in a Glass of Beer: Simple Experiments in Atmospheric Physics, Craig F. Bohren. Mineola, N.Y.: Dover Publications, Inc., 2001 (reprint from 1987). Paperback, 195 pp., $11.95

The Complete Book of Holograms: How They Work and How to Make Them, Joseph E. Kasper and Steven A. Feller. Mineola, N.Y.: Dover Publications, Inc., 2001 (reprint from 1987). Paperback, 216 pp., $10.95

Revealing the Universe: The Making of the Chandra X-ray Observatory, Wallace Tucker and Karen Tucker. Cambridge, Mass: Harvard University Press, 2001. Hardcover, 295 pp., $27.95

Life Beyond Earth, Timothy Ferris, New York: Simon & Schuster, 2001, Hardcover, 222 pp., $40.00

AN ANCIENT INSTRUMENT COMES ALIVE

Bertram Cooper

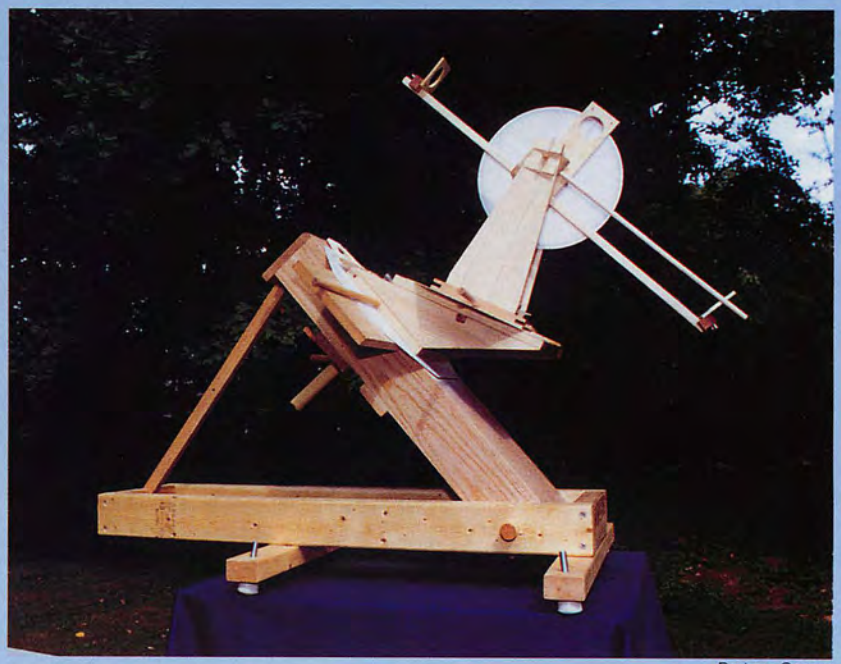
The torquetum, a kind of analogue computer for astronomical measurements, was known to be used during the Renaissance to find latitude, and to calculate the angular distance of the Moon or planets from other heavenly objects. So, when epigrapher Barry Fell—who had a classical education and a knowledge of astronomy—saw a photograph of an ancient cave drawing from Irian Jaya, which Navigator Maui in about 232 B.C. called his "calculator" or *tanawa,* Fell recognized it as a torquetum.

In the Ancient Discovery section, Rick Sanders and Bert Cooper bring to life a model of Maui's *tanawa,* and describe their experiments to prove in principle that Maui's expedition to circumnavigate the globe 2,332 years ago, could have used the *tanawa* to measure longitude during the journey.

In this famous 1533 painting, The Ambassadors, Hans Holbein the Younger (1497-1543) depicts the French ambassadors in London with an array of scientific instruments, including a torquetum (top right of painting and detail at right). Holbein went to England from Switzerland with a recommendation from Erasmus of Rotterdam, and became the court painter for Henry VII and Henry VIII.

Closeup of the torquetum, showing the 14-inch equatorial circle for sidereal time (on the instrument's polar axis); the 12-inch annual circle divided into 24 hours (parallel to the plane of the ecliptic); and the declination circle.

The National Gallery, London



Bertram Cooper

The torquetum with sighting bar in place.

In This Issue:

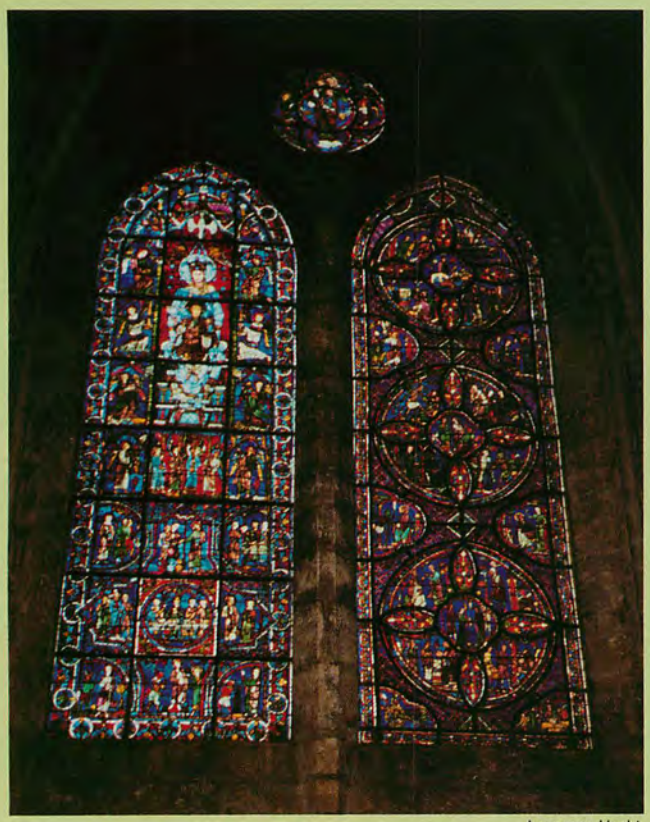
The great cathedral of Notre Dame de Chartres still towers over the French city by which it is named.

P. Messer

How the Cathedral Builders Fought for Science

The intellectual movement behind the great medieval Cathedrals was a first Renaissance, as Philippe Messer documents. A battle among the philosophical leaders of the Church pitted those who wished to revive the science of classical Greece as a means of uplifting society, against those, such as Bernard of Clairvaux, who argued that God had intended man for a life of ignorance. Arguing for the study of science, William of Conches, the master of the Chartres school, wrote of his opposition:

> "As they are ignorant of the forces of nature, they wish us to remain bound to their ignorance, reject our right to investigate, and would have us live like bumpkins, in belief without intelligence."



Laurence Hecht

Magnificent stained glass windows illuminate the south wall of the nave of Chartres Cathedral.

Music (above) and Pythagoras (below) are portrayed in this detail of sculpture from the right arch at the royal portal of the Chartres Cathedral.

P. Messer