21st CENTURY SCIENCE & TECHNOLOGY
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Creativity as A Universal Principle

- On the 150th Birthday of Max Planck
- Modular High-Temperature Reactors Can Change The World
- Space Exploration Moves East

21st CENTURY
SCIENCE & TECHNOLOGY

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Features

PBMR

South Africa's Koeberg nuclear plant. The PBMR demonstration reactor will be built nearby. *See interview, page 52.*

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ON THE COVER: A scene from the LYM video "The Matter of Mind," with Peter Martinson portraying Bernhard Riemann. larouchepac.com/news/2008/12/15/lpactv-matter-mind.html. Cover design by Alan Yue.

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Nuclear Power, Not 'Green' Jobs For a Sustained Economic Recovery

There's no way to achieve economic prosperity without nuclear power. The world needs 6,000 new nuclear plants by the year 2050, just to make sure the lights stay on and that everyone in the world has electricity. (Now more than a billion people are without it—a crime in the 21st Century.) We need to build all sorts and all sizes of nuclear plants—advanced conventional reactors, high-temperature reactors, breeder reactors, fusion-fission hybrids, and others.

The idea that creating "green" jobs will save the economy is idiocy. Environmentalism as promoted today is a mental illness, the final stage of the rock-drug-sex counterculture imposed deliberately on this country to stop its development as a world power. A functioning economy with advanced technologies is the way to improve and sustain the environment and keep it "green." Other ideas of "green" are just another way of killing people, by ensuring that society will not be able to support its population. (Population reduction is, in fact, the stated aim of some of the well-known Greens.)

The nuclear renaissance is entirely possible—if we stop bailing out the rotten world financial system and replace it with a New Bretton Woods agreement like that of Franklin D. Roosevelt. The salient points are a fixed rate for currency exchange and a two-tier credit system, with a low (1 to 2 percent) preferential interest rate for infrastructure building and other productive investment. The first step is to put the present banking system through an orderly bankruptcy reorganization, maintaining the legitimate banking functions and throwing out the speculative garbage. (Economist Lyndon LaRouche has spelled out the New Bretton Woods details, which you can find at www.larouchepac.com/files/pdfs/110208_Nov_11_Resolution.pdf.)

Either we reorganize the financial system along these lines and make a nuclear renaissance, or the world collapses into a New Dark Age fast—drowning all those who cling to the illusion that we can patch things up some other way.

The essential point, however, is to think not of monetary systems, but of the actual productive basis for real wealth production. Monetary and currency arrangements produce nothing; they are merely a means of facilitating. We must think of our future generations, as we design 25- to 50-year projects that will ensure the well-being and growth of the nation. Whatever is necessary to keep the nation functioning—railroads, power, water, sewage systems, health care, education—has to be done. As our Founding Fathers Washington, Hamilton, Franklin, and others knew, providing government credit to build the nation's basic infrastructure is an investment that pays off mightily in the long term.

The American System of Economy

The United States was designed as a credit system in which the Constitution granted to Congress, not the private banking system, the ultimate power to issue credit (Article I, Section 8). Our system was designed in explicit opposition to the notions of British East India Company propagandist Adam Smith. It allows business and commerce to function and encourages individual entrepreneurs to develop their new ideas. With basic infrastructure in place, the population has the ability to develop itself, making the new discoveries that will improve the condition of mankind.

In the American System of Political Economy, "People Are Wealth." This was the watchword in Abraham Lincoln's time, as laid out by his economic advisor Henry C. Carey and others, and it built the greatest industrial economy the world had ever seen. The basic idea is that the brainpower of its citizens is a country's greatest resource, and so the nation must have adequate wages, housing, health care, and education to ensure that it makes the most of this resource. Given the opportunity, man's mind, advancing science and technology, can make *infinite* progress.

This American System was founded and developed in direct opposition to the British System of Adam Smith and Thomas Malthus, which treated human beings as cattle, and colonies as places to loot.

In the 20th Century, President Franklin D. Roosevelt renewed the spirit of the American System. Roosevelt's Tennessee Valley Authority for example, took the most backward and poverty-stricken area of the nation, and pulled it into the 20th Century, in a model for development admired around the world. FDR's New Deal programs put people to work, gave them hope and sustenance, and built the United States into an industrial giant—in just a few years, not decades. We are still living off the shards of that infrastructure, 70 years later.

We can become a great nation once again, by removing the "cost-benefit" straitjacket of the small-minded accountant and thinking big; thinking not of overnight "profit," but of the immense benefits to society 25 and 50 years forward of investment today in infrastructure. Given low interest credit, the state and local governments, utilities, and other productive companies can begin with confidence to build the power and transportation projects that the nation (and the world) needs.

The Science Driver

The driver of a healthy economy has to be science and technology, mission-oriented projects that will capture the imagination of the nation and develop the talents of the younger generations:

• We need a robust space program, looking to colonization of the Moon, Mars, and beyond.

• We need a crash program to develop fusion power and other forms of advanced energy, including the anomalous nuclear effects implied by the phenomenon of cold fusion. We desperately need the fusion torch, to replace the current labor-intensive nature-destroying form of mining, and to turn ordinary garbage into its constituent elements as new resources.

• We need to create the isotope economy of the future, which will enrich us by opening up the entire Periodic Table of the Elements for mankind's use.

• Overall, we need to push forward the frontiers of biology, medicine, and other disciplines, by returning to the principles of classical science and classical education, abandoning Newtonianism, and creating a nation of thinking beings capable of making full use of their creativity.

Nuclear advocates don't need to be convinced of the need to go nuclear, but they do need to change their way of thinking about the economy. Nuclear won't happen unless we get out of the accountant's balanced-budget approach, and go with the New Bretton Woods as LaRouche has proposed it. Wall Street's "bottom line" prescriptions and high interest rates, after all, are what killed nuclear power in the United States in the 1970s. Why follow the same failed charlatans today, when it is all too evident that these Wall Street geniuses succeeded only in driving our economy into collapse?

Wind Power: 'Whump, Whump, Whump'

To the Editor:

A few years back, I commuted from Oakland, California, thru Altamont Pass on my way to work at Lawrence Livermore Laboratory. Windmills were set up in the hills near the pass. My God, were they noisy. Whump, Whump, Whump, day and night. People nearby had to leave their homes. It was terrible to be stuck hearing that sound. I appreciate your article ["Windmills for Suckers: Pickens' Genocidal Plan," by Gregory Murphy, www.21stcenturysciencetech.com/Articles%202008/Windmills.pdf], but I think you should add this fact to your arsenal.

Also I remember the $5,000.00 cost of the bearings for each site.

Using 200,000 acres, 2,000 windmills, and a square site matrix, I came up with over 2,000 feet between sites. This seems like an incredibly high spacing distance. Maybe land-grab spacing distance.

Pickens can shove his wind power program you know where.

Tom Pickett

We Need the Benefits of Medical Radioisotopes!

To the Editor:

In recent weeks, I've read several articles which have been published in *21st Century Science & Technology* magazine concerning the benefits of radioisotopes, especially in the areas of preventive medicine and disease treatment.

While radioisotopes may be able to treat various degenerative diseases, particularly those diseases which afflict the now-aging "Baby Boomers," there are a couple of questions which have been on my mind for some time. . . .

Even if the Boomers were able to overcome their knee-jerk reaction against anything which has to do with nuclear energy and demand that they be treated with radioisotopes, there are few medical professionals who are qualified to use radio-isotope based nuclear medicine, so my first question is how would medical professionals be adequately trained to use radioisotopes in treating various dis-

Continued on page 6

The Evidence for Gamma Ray Photosynthesis

by T.D. Luckey

Abstract. Limited data indicate that gamma rays can support photosynthesis. Pure cultures of a photosynthetic bacterium, *Rhodopseudomonas capsulata*, and an alga, *Anacystis nidulans*, were exposed for several days, without light, to continuous gamma rays from a Co-60 source at the University of Missouri Research Reactor. Both organisms remained green and, within limits, increased in proportion to the radiation flux. The results indicate microbial use of the energy of ionizing radiation in deep sea vents, hydrocarbon utilization, prebiotic reactions, and early life metabolism.

* * *

Introduction. "The longer my experiments continued, the more mysterious the whole subject seemed." This was O.F. Atkinson's reaction to the increased growth of algae irradiated with X-rays in 1898.[1] During the 20th Century, about 3,000 scientific reports showed a biopositive effect for many physiologic functions following low doses of ionizing radiation in microbes, plants, invertebrates, and vertebrates, including humans.[2,3,4] Within limits, the response is directly proportional to the logarithm of the dose. When the dose exceeds the threshold for each set of parameters, a bionegative effect is observed. Increased photosynthesis was indicated by the increased mass of photosynthetic organisms following pulsed or continuous radiation with beta rays, gamma rays, X-rays, ultraviolet (UV) rays, or neutrons.[2] In the above experiments the plants were exposed to ambient light.

Would plants respond to ionizing radiation without light? A positive answer is indicated by the response of a photosynthetic bacterium, *Rhodopseudomonas capsulata,* and an alga, *Anacystis nidulans,* to continuous exposure of cobalt gamma rays without light. The implications of this finding are discussed below.

Method. Aseptic techniques were used throughout this study. Sets of tubes to be irradiated were put in an incubator which was placed at a convenient distance from the Co-60 source in the University of Missouri Research Reactor. For *R. Capsulata,* the front of the incubator was 24 cm from the Co-60 source; it had a 1.8-cm lead plate between it and the source. Within the incubator radiation was attenuated by a series of lead plates providing a sequence of 0, 1.6, 3.1, 4.8 and 6.4 cm of lead between the five sets of tubes and the source.

The Co-60 was elevated from the pool to give continuous in-air irradiation, with no light, of cultures throughout the incubation periods. Dosimetry for the five positions included backscatter from incubator, lead plates, and concrete walls. Control cultures were maintained in the dark with no irradiation at the appropriate temperatures in incubators in a separate building.

R. capsulata (B100) stock cultures were maintained anaerobically at 32°C under fluorescent light of 50 foot-candles, following procedures outlined by Madigan *et al.*[5] The complete medium, RCVB, of Johansson and Gest was used for stock

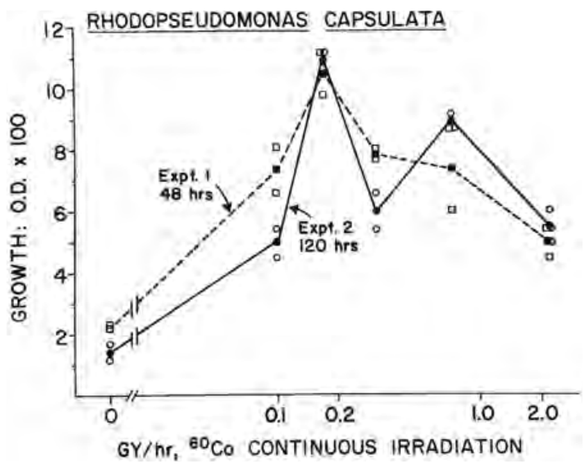

Figure 1
GROWTH OF *R. CAPSULATA* WITH CONTINUOUS IRRADIATION
Each circle represents an individual culture of growth of R. capsulata *in the dark, with continuous Co-60 irradiation.*

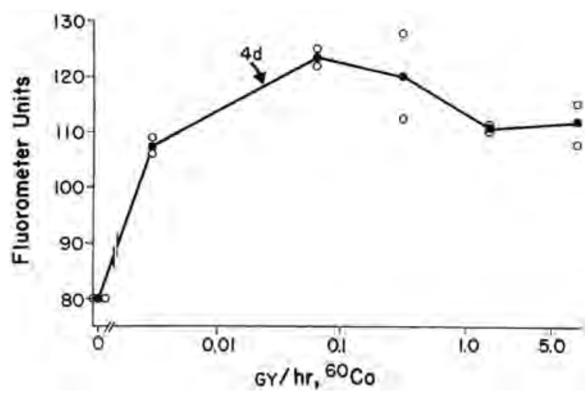

Figure 2
GROWTH OF *A. NIDULANS* WITH CONTINUOUS IRRADIATION
Each circle represents one culture of growth of A. nidulans *after four days of continuous Co-60 irradiation in the dark.*

cultures.[6] The culture medium was RCVB formula at pH 6.8 with 40 millimolar (mM) fructose replacing the malate. A 48-hour culture from the stock culture was centrifuged and re-suspended in 0.9 percent sodium chloride to form the inoculum. Tubes were flushed with sterile nitrogen (N_2), almost filled with culture medium containing 0.1 milliliter (ml) fresh inoculum per 10 ml, tightly sealed with screw caps, and mixed by inversion using the 0.2 ml bubble to provide motion.

All experimental and control cultures were incubated in complete darkness. Control tubes maintained at ambient radiation levels included uninoculated medium, inoculated negative control (not irradiated), and inoculated (not irradiated) positive control. The last group contained 60 mM dimethyl sulfoxide (DMSO) as an acceptor for electrons and protons in anaerobic metabolism. The total microbic mass was determined by turbidity using the uninoculated medium for the photometer blank at 620 nanometer; one O.D. unit represents approximately 108 bacteria per ml.

The stock and the positive control cultures of *A. nidulans* were maintained in light at 50 foot-candles with no ionizing radiation. All experimental cultures were maintained in the dark in an incubator (without a lead plate in front) 1.5 meters from the Co-60 source. Ten-ml medium (Alga-Gro, pH 7.0 from Carolina Biological Supply Co., Burlington, N.C.) was placed in each 20-ml tube with loose screw caps, autoclaved, cooled, and provided one drop of inoculum from a culture one week old. Total microbic mass was determined by spectrophotofluorometer at 350 nm in quartz cuvettes.

The Results

The dose-response curve of *R. capsulata* (Figure 1) showed a maximum growth at 0.16 gray per hour for both 48 and 120 hours exposure. Exposures greater than 2 Gy/h were not attempted. All cultures were a uniform green. Both irradiated and unirradiated cultures which contained DMSO had about six times more growth than the maximum in irradiated cultures without the DMSO.

The dose-response curve of *A. nidulans* (Figure 2) produced a partial rainbow, with the growth zenith at 0.08 Gy/hr. The far side of the rainbow was interrupted by a horizontal component which showed no evidence of a threshold at the highest exposure, 5 Gy/hr. Illuminated control cultures grew four times faster than any of the irradiated cultures. All cultures remained green.

Discussion

Gamma ray photosynthesis. The results show that continuous irradiation with gamma rays, without light, increased photosynthesis in two photosynthetic organisms. The mechanism of action of gamma ray photosynthesis is probably not the classic activation of plant chlorophyll, which requires many photons acting as a single cohort in one reaction center, to cleave water and produce free hydrogen and oxygen.[7] The only biological reaction which does this is photosynthesis. Improbably, the haphazard action of a multitude of free radicals could induce photosynthesis.

In contrast to the above, the consistent action of ionizing radiation is known. Low-energy gamma rays can transfer a photon to an atomic electron by either the photoelectric or the Compton effect (J. Muckerheide, personal communication). In this process, photosynthesis probably results from the transfer of energy to an atomic electron by the ever-decreasing photon energy as gamma rays penetrate matter.

Since gamma rays support photosynthesis, ionizing radiation may be considered to be a major source of energy for subsurface microorganisms. This has major implications for ionizing radiation as an energy source in deep sea vents, petroleum utilization, and the origin of life.

Deep Sea Vents. S.N. White listed various sources of light in deep sea hydrothermal vents: Cerenkov radiation, thermal (blackbody) radiation, temporary visible light, vapor bubble luminescence, crystalloluminescence, triboluminescence, chemiluminescence, and bioluminescence.[8] J.T. Beatty and associates suggest that anaerobic, green sulfur bacteria utilize blackbody radiation from deep sea hydrothermal vents.[9] Chlorophyll of similar bacteria from 100 meters deep in the Black Sea received one photon every eight hours. These are stored in a chlorosome and provide sufficient infrared photons for the bacterium to survive, with a cell division time of about 2.8 years. This is not fast enough for a colony to contribute to the ecosystem, or even survive, in the turbulent waters near the deep sea vents. A consistent, and much stronger, source of energy is ionizing radiation.

D. Kadko reported an abundance of radionuclides in deep sea vents.[10, 11] Also, S. Charmasson et al. report unusually high concentrations of the uranium-thorium families in vent organisms.[12] Most forms of ionizing radiation stimulate physiologic functions in microbes, plants, and animals.[2] Thus, ionizing radiation is undoubtedly one source of energy for life around deep sea hydrothermal vents.

Petroleum. After hydrogen and helium, carbon is almost as abundant as oxygen in the universe and in our Solar System.[13] Methane was one component of the aggregates which spawned the Earth. T. Gold noted that great stores of liquid methane were deep in the Earth's crust and upper mantle, with pressures up to 40,000 times ambient and temperatures exceeding 1,000 °C.[14] Gold cites evidence that this is both the past and current source of hydrocarbons for gas, oil, and black coal (brown coal and lignite are exceptions with biogenic origins).

The upwelling of petroleum products through pores and crevices of rocks is food for an underworld of Archaea and primitive bacteria which exceeds the mass of living organisms of the Earth's surface by a factor of 10. Some thermophiles and hyperthermophiles have an optimum temperature of 80°C.[14] The data indicate ionizing radiation from Earth's radionuclides would supply ample energy for hydrocarbonphiles in the absence of sunlight. Here is the driving force for biochemical energy production in hydrothermal vents of the ocean floors and the deep hot biosphere of Earth or other planets.

Origin of life. These limited data on gamma ray photosynthesis provide evidence for a role of ionizing radiation in the origin of life. Radiolysis of water produces the troika of energy metabolism: oxygen, hydrogen, and electrons. This provides a constant source of different oxygen species (Table 1).[15] These reactive species oxidize the many free radicals of organic compounds produced by ionizing radiation. For example, oxidized hydrocarbons would stabilize newly formed cell walls, the bastions of life, and provide an inexhaustible source of energy. Ionizing radiation provides a framework for many prebiotic and early life reactions.

Because of the relatively short halflives of potassium-40 and uranium-235, Earth had about 10 times more ionizing radiation when life began, about 3.9 billion years ago[16] than it has now.[17] Activated electrons would migrate to form more stable (lower energy) compounds. About 3.7 billion years ago, low-energy radiation (light) became a source of activated electrons to utilize water in photosynthesis. As shown by stromatolite fossils, which are dated at 3.6 billion years ago,[16] photosynthesis evolved to utilize low-energy photons. These reactions continue on the Earth's surface while ionizing radiation fuels metabolism underground.

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He is a member of the board of directors of Radiation, Science, and Health, and he is an honorary member of the International Society of Hormesis and Environmentalists for Nuclear Energy.

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T.D. Luckey. The author became an honorary Samurai in 2003, for bringing knowledge of radiation health to Japan.

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Letters

Continued from page 3

eases, especially in those Boomers and others whose medical conditions are "too far advanced" for them to be treated successfully?

Also, when it comes to treatment with radioisotopes, there are many insurance companies which claim that this treatment is "experimental" and refuse to cover it as part of a health insurance plan, which may lead to a "rationing" of care with this type of treatment, where only the young who have a better possibility of survival will be treated with radioisotopes, while aging Boomers are denied this type of medical care because the insurance companies believe that treating an aging Boomer is "too risky," possesses no real "cost-benefit," and is not worth the extra expense.

In light of this, my second question is what would have to be done in order to convince medical professionals and the insurance companies—including Medicaid and Medicare—that nuclear medicine is a valuable resource and that using isotopes as part of medical treatment is actually more cost-effective and safer than feeding patients massive amounts of drugs which can compromise their immune system or do serious harm to their bodies?

I'm eagerly looking forward to the answers to these questions, because they've been on my mind for quite some time.

Stephanie Fryar

The Editor Replies

Your questions are good, and should be answered! We'll attempt a brief response here, and will pursue fuller answers from some of the scientists working in the field.

We have an article in preparation on medical isotopes, and in particular on the fact that despite several government studies saying that the United States should produce medical isotopes domestically, the government has shut down existing programs and has not funded new ones. So, we still must import 90 percent of the medical isotopes used.

There are some areas where treatment of medical isotopes has made it into the mainstream here: breast cancer and prostate cancer. But you are right: The

Pacific Northwest National Laboratory

Tiny radioactive seeds of cesium-131, which are used in treating prostate cancer. The X-ray emitting seeds are implanted near or in a tumor, where the seeds kill the cancer cells without serious side effects.

United States does not routinely use targetted radiotherapies. These new treatments are used much more widely in Europe.

Also, although it is known (from research in Japan) that for lymphoma patients, low-level whole-body irradiation prior to targetted higher-level radiation to the tumor site greatly enhances successful recovery and lifespan, there is nowhere in the United States that you can have this treatment. When I convinced a leading oncologist who heads a cancer treatment center at a major hospital to try this for one of my family members, the doctor pulled out at the last moment, under peer pressure.

Diagnostic procedures with radioisotopes are routine, and there are many technologists and doctors qualified to use them. So, there already exists a group of people who could be "trained" to use isotopes with treatment. The issue here with diagnostic procedures is that the more advanced scans that use radioisotopes, like PET, are expensive. Insurance companies don't want to pay for them, and there is already debate in the medical community about whether it's "worth" it to detect a cancer early and treat it.

The problem has to be approached both from above and below. There has to be a cultural shift in the medical profession to look at these life-saving technologies as better alternatives to blasting people with chemotherapy. There have to be many more protocols and trials of these technologies, and learning from cancer treatment in other countries where it is clear that some isotopic therapies work and further trials are not necessary.

And from "below," patients have to start demanding better treatment. In many cases, the targetted radioisotope treatments are less expensive or no more expensive than the more traditional treatments, which should help with the insurance issue. The expense is in procuring the isotopes, which are often short-lived, so of course if we produce them domestically this will lessen the cost of transportation. And new methods of isotope production are being demonstrated, which can be located in facilities near hospitals and medical centers.

Overall, the attitude toward radiation has to change. Not an easy task when you have an anti-scientific population. The group Radiation, Science & Health, headed by Jim Muckerheide, has been working on changing the linear no-threshold lie within the nuclear community and all the relevant government agencies. But the idea that the only good radiation is zero radiation is very entrenched. One of the medical professionals, an oncologist, who was working at the Nuclear Regulatory Commission as an emeritus professor, was forced out because his views on the benefits of low-level radiation angered a couple of the commissioners, who toed the LNT (Linear No-Threshold) line.

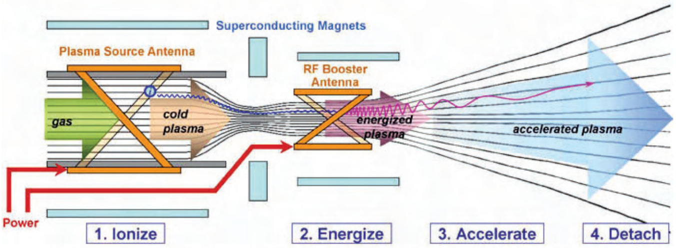
"Alternative medicine" now is a big business, especially with the Boomer population concerned with aging. But radiation now plays no part in this field. Yet, the research conducted in Japan showed that low-level radiation was beneficial against many diseases of aging, including diabetes. And the treatment is definitely cost-effective.

Some of the *21st Century* articles on this subject include: "Interview with Sadao Hattori: Cancer Suppression and Rejuvenation Using Low-dose Radiation," Summer 1997; "It's Time to Tell the Truth About the Health Benefits of Low-Dose Radiation," by James Muckerheide, Summer 2000; "How Radiation Saves Lives," by Jim Muckerheide, Winter 2004-2005; "The Signficant Health Benefits Of Nuclear Radiation," by Jerry M. Cuttler, D. Sc., Fall 2000; "Low Dose Radiation Cures Gangrene Infections," by Jerry M. Cuttler, Spring-Summer 2007; and "Medical Isotopes in the 21st Century," by Dr. Robert E. Schenter, Winter 2007-2008.

PLASMA ROCKET MAY BE TESTED ON THE INTERNATIONAL SPACE STATION

NASA signed a Space Act Agreement with the Ad Astra Rocket Company in Texas on Dec. 8, which could lead to the testing of a plasma-based propulsion system, aboard the International Space Station. The Variable Specific Impulse Magnetoplasma Rocket, or VASIMR, was developed by former astronaut Dr. Franklin Chang-Diaz. Its utlimate goal is to use a fusion reactor to provide the plasma for a revolutionary propulsion system, reducing the travel time for a manned mission to Mars from months, to weeks.

In the proposed space test, a conventional source of electricity would be used to heat an ionized fluid, which would serve as a propellant, creating a small thrust from the engine. See www.youtube.com/watch?v=-537—RJb80 for a NASA video on VASIMR with Chang-Diaz.



Ad Astra's diagram of the VASIMR Rocket. The Plasma Source cell involves the main injection of a neutral gas like hydrogen to be turned into plasma and the ionization subsystem. The RF Booster cell uses electromagnetic waves to energize the plasma to the desired temperature. The Magnetic Nozzle then converts the plasma energy into directed motion and ultimately useful thrust.

FUSION PIONEER PROPOSES 10-YEAR PLAN TO BUILD A FUSION PLANT

Fusion scientist John Nuckolls proposed "A 'Yes we can' 10-Year Inertial Fusion Energy Development Strategy," which he said could be accomplished with 10 percent of President-elect Obama's $150 billion projected 10-year energy program. He suggested "four steps to fusion power: build an efficient high average power laser module, a target factory module, and a fusion chamber; build a surged, heat capacity inertial fusion energy system; build a fusion engine; and build a fusion power plant."

Nuckolls, emeritus director at Lawrence Livermore National Laboratory, made the proposal at the annual meeting of Fusion Power Associates, Dec. 3-4, where he and fellow fusion pioneer Richard F. Post were presented with FPA Special Awards for their "pioneering contributions to fusion energy development." Post and Nuckolls have been active fusion researchers since the 1950s, and both have made important contributions to magnetic and inertial fusion, respectively. The FPA meeting also hosted a 90th birthday celebration for Post.

Post commented: "We have the basic scientific understanding, the computational horsepower, and the technology to take a new, broader, look at the problem. And we certainly have the financial wherewithal. For example, we are spending $700 billion a year to import oil. One week of that rate of expenditure—$11 billion—is equal to the entire U.S. magnetic fusion funding over its 56 plus years of existence. A .4 percent tax on that oil could pay for a fusion budget that is a factor of 10 larger than the present budget."

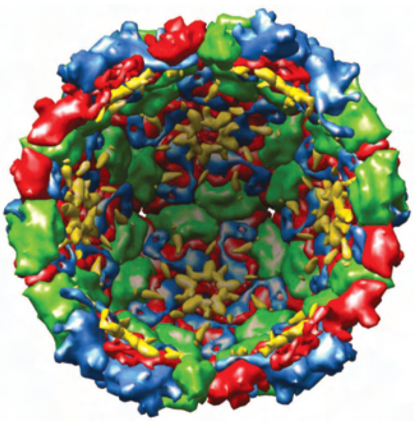
The FPA conference presentations are available at http://fusionpower.org.

X-RAY BEAMS REVEAL STRUCTURE OF CANCER-FIGHTING VIRUS

Viruses are known to have specificity for certain cell or tissue types, as well as host species preferences. These specificities can make them potentially powerful tools in targetting human diseases such as cancer. A picornavirus recently isolated from tissue cultures, and christened Seneca Valley virus, shows an extremely high selectivity for small cell lung cancers and certain other neuroendocrine tumors with minimal toxicity. The virus-based therapy has been developed by Neotropix, Inc. of Malvern, Pa., and is now in clinical trials. (See http://www.neotropix.com for more details.)

Recently, in an effort to find out how the picorna virus works, a group at The Scripps Research Institute, led by Dr. Vijay S. Reddy, used the BioCARS (http://cars9.uchicago.edu/biocars/index.html) X-ray beamline at the Advanced Photon Source at Argonne National Laboratory to build three-dimensional images of the virus. The imaging is a first step in identifying regions on the virus coat important for attachment to cancer cells, Reddy said. "It will be critically important to find out what region of its structure the virus is using to bind to tumor cells, and what those cancer cell receptors are. Then we can, hopefully, improve Senecavirus enough to become a potent agent that can be used with many different cancers."

These 3-D images have joined hundreds of others in the Scripps database, Virus Particle Explore, which can be accessed at http://viperdb.scripps.edu/.



Courtesy of Scripps Research Institute

Inside 3-D view of the Seneca Valley Virus-001 showing the icosahedral structure of the capsid and the arrangement of major proteins.

MT. WILSON OBSERVATORY CELEBRATES TELESCOPE CENTENNIAL

Mount Wilson Observatory's historic 60-inch telescope, which celebrated its 100th anniversary in December, marked a revolution in astronomy in the early 20th Century. Commissioned by astronomer George Ellery Hale under the auspices of the Carnegie Institution of Washington, it was designed by astronomer George Ritchey and took more than 14 years to complete. The telescope demonstrated that large silver-on-glass reflectors were practical, and became the basic design for all future observatory telescopes. Designed to operate in several different optical configurations for research purposes, it was the first telescope built primarily for photographic and spectrographic use. Its five-foot-diameter mirror made it the largest telescope in the world until 1917.

In the early 1900s, the Hale telescope made the first measurement of the Milky Way galaxy's size and the Solar System's position within it, including Earth. This discovery was made by astronomer Harlow Shapley, who used the telescope to observe globular star clusters and variable stars to determine the distances to these stars. He found they were distributed spherically with respect to the Milky Way, and that the Sun was not in the center of their distribution. Shapley reasoned that the Sun must thus also not be at the Milky Way's center.

The 60-inch telescope, now retired, is the world's largest telescope devoted to public viewing. More information on scheduling access is available at www.mtwilson.edu.

Craig Mathew/Mathew Imaging

The historic Mount Wilson 60-inch telescope. Inset: Brothers Sam (left) and Brack Hale look through the telescope founded 100 years earlier by their grandfather, pioneer astronomer George Ellery Hale.

NEW SCIENTIST ADVOCATES OPTIMAL GREEN 'FINAL SOLUTION'

There's nothing new or scientific about *New Scientist*'s Malthusianism. In answer to the question, "What is the single most effective thing I can do for the environment?" the British weekly stated: "Over a 75-year lifespan, the average European will be responsible for about 900 tonnes of CO_2 emissions. For Americans and Australians, the figure is more like 1,500 tonnes. Add to that all of humanity's other environmentally damaging activities and, draconian as it may sound, the answer must surely be to avoid reproducing."

ARTHUR KANTROWITZ, MULTI-FACETED SCIENTIST, DIES AT 95

Dr. Arthur Kantrowitz, who died Nov. 29 at the age of 95, made discoveries at the frontiers of science and technology all his life, and held 21 patents. Trained in fluid dynamics, in the 1950s he invented the use of ablative cooling to allow the reentry of missiles, and then spacecraft, through the Earth's atmosphere. Kantrowitz did early research in fusion, and helped design the intra-aorta balloon pump, which has been used on 3 million heart patients (including himself).

Kantrowitz taught at both Cornell and Dartmouth, and he founded and directed the Avco Everett Research Laboratory in Massachusetts. His work at the laboratory included research on high-energy lasers and magnetohydrodynamics. In 1958, Kantrowitz and space visionary Krafft Ehricke presented a joint proposal before Congress for a manned space station.

A member of the National Academy of Sciences, Kantrowitz was as at ease discussing the philosophical roots of science, as he was in talking about almost every field of science. His passion for many years was to remove "ideology" and environmentalist irrationality from science, through the use of "Science Courts."

Kantrowitz decried the "timidity" of science, in an article he wrote for the March-April 1990 issue of *21st Century,* on "The U.S. Space Program and the Ming Navy." "In spite of a clear historical record showing that adventurous, science-based technology has discovered and *created* new resources even faster than their consumption by a wasteful society," he wrote, "a governing segment of our society has embraced facile computerized resurrections of Malthusian 'limits to growth' doctrines."

Arthur Kantrowitz (1913-2008).

Compiled by Gregory Murphy

Sea-level Scientist Mörner Receives 'Golden Chondrite' Award

The University of Algarve awarded sea-level expert Nils-Axel Mörner the "Golden Condrite of Merit" at the IGCP-495 meeting of geoscientists in Algarve, Portugal, Oct. 27-Nov. 1. Mörner is known for his insistence that there is no global sea level rise, despite the unfounded claims of global warming scaremongers.

Courtesy of Prof. Tomasz Boski

The Ourique meteorite, soon after its fall in Portugal in 1998.

The award, a piece of the Ourique Meteorite mounted on a silver plaque, was given for Mörner's "irreverence and contribution to our understanding of sea-level change." Given by the top scientists in sea level research, the award is a testimony of the respect for Mörner's work in telling the truth about sea level rise. (See an interview with Mörner at www.21stcenturysciencetech.com/Articles %202007/MornerInterview.pdf.)

"Of course, I am very happy for this. But it has also a significance in the ongoing sea level debate," Möerner said. As one fellow scientist commented: "The golden chondrite is in good hands. The empire of darkness and doom will tremble."

The IGCP (International Geoscience Program) is a cooperative enterprise of UNESCO and the International Union of Geological Sciences, formed in 1972.

Enlisting the Dead To Fight Global Warming

The Spanish town of Santa Coloma de Gramenet, near Barcelona, has found a rather novel use for the dead: as a tool to fight global warming. Conste-Live Energy and the local town council has turned the city graveyard into a solar farm by placing hundreds of solar panels on top of the mausoleums, to provide what the energy company says will be year-round power for homes.

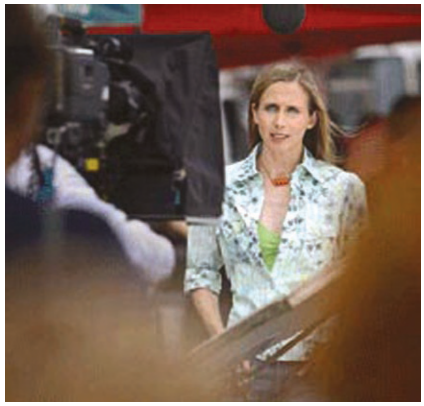
"The best tribute we can pay to our ancestors is to generate clean energy for new generations," said Esteve Serret, a Conste-Live Energy director. Conste-Live Energy and the local town council spent three years persuading relatives of the interred and the nearby residents that the unusal proposal would benefit the living without demeaning the dead.

For all this trouble, the 462-panel solar farm, which cost 720,000 euros to install, will supply part-time power to 60 homes. I certainly hope the residents of Santa Coloma are not holding their breath for all of that promised clean energy.

NBC Fires Weather Channel Environmental Unit

The National Broadcasting Company, owner of the Weather Channel, fired the entire staff of its climate alarmist "Forecast Earth" program on Nov. 12, 2008, during NBC's major greenie week, in which the network sent people to Mount Kilimanjaro and Anarctica to showcase the so-called dangers of global warming.

Off the air.



Courtesy of The Weather Channel

Heidi Cullen, the Weather Channel climate expert who thinks that meteorologists who don't agree with her should lose their professional accreditation.

Although NBC said it cut the program because of financial constraints, the move may be related to the fact that its parent company, General Electric, is getting out of the renewable energy game. General Electric Financial Services announced Oct. 21 that as a result of the Lehman Brothers bankruptcy, it was bailing out of the clean-tech investment game, after existing projects are finished.

Now, what about Heidi Cullen, the Weather Channel's resident global warming alarmist who said that the American Meteorological Society should pull the accreditation of all meteorologists who question global warming? Maybe NBC will have the good sense to send her packing.

Global Warming Nutcase Files Suit in Soros-Owned International Court

Global warming nutcase Danny Bloom filed a class action lawsuit in the Soros-owned International Criminal Court in the Hague, the Netherlands, in November 2008, against the refusal of national governments to act to reduce their carbon emissions.

Bloom, who is tied to the Sierra Club, is asking for "$1 billion in damages caused by climate change on behalf of future generations of human beings on Earth—if there are any."

This case is a real publicity stunt, filed just three weeks before the United Nations Framework Convention on Climate Change meeting in Poland.

Bloom has to be a real numbskull to ask for a mere billion dollars from national governments that have have been pumping trillions of dollars into the bankrupt financial system.

James Hansen's Extremism Exposed Again

NASA's resident global warming fruitcake James Hansen announced on Nov. 10 that October 2008 was the hottest month on record, despite the fact that none of the other four major groups that monitor global temperature showed such a dramatic rise in the temperature data for the month.

It turns out that the Goddard Institute for Space Studies, of which Hansen is the director, had used faulty data from Russia in its October monthly data. The Russian data contained what is called an "observer bias": The observers had logged the exact same numbers for the months of September and October. Hansen should have caught this mistake since the Russians post their data on their weather service website.

Further investigation by climate researcher Anthony Watts revealed another problem: The three Russian sites with the questionable data have their temperature monitoring stations located near uninsulated steam piping, which produces temperature readings that are about 10 degrees warmer than the surrounding air.

Hansen should have noticed that his temperature record for October just did not match with reality. In 2008, London experienced its first snow storm in October since 1932, while the U.S. National Oceanic and Atmospheric Administration recorded no less that 115 low-temperature records and 63 local snowstorms during the month of October. And during the last week of October, the Canadian government announced that at least 200 narwhals were trapped in the refreezing Arctic ice surrounding the Baffin Bay area.

Perhaps Dr. Hansen should poke his head outdoors for a few minutes, before making his next climate evaluation.

Climate Agreements Falter As Economic Reality Strikes

The global warming lie was never anything more than a means of getting nations to commit economic suicide in the interest of strengthening the hand of the Anglo-Dutch financial empire. Now, with the collapse of the global Ponzi scheme that replaced the once-sound Bretton Woods financial architecture, nations are rethinking their commitment to carbon caps, emission controls, and other economy-wrecking measures.

As the global financial crisis worsened over the Fall, an open brawl emerged over the European Union Climate Protection bill, which would cut carbon emission drastically by the year 2050 and kill industrial jobs. It started with Poland and Italy, which both said that they would veto the bill in the European Parliament.

Then German Chancellor Angela Merkel, who had been one of the real attack dogs in favor of the climate protection bill, weakly announced that she would oppose the bill if it meant the loss of German jobs. Her change of mind came a result of heavy pressure from the heads of the manufacturing and agriculture-oriented German federal states controlled by Merkel's own CDU party.

For example, Horst Seehofer the Bavarian state leader, said in an interview that he had written to Merkel calling on her to back away from EU climate protection goals that were to be approved the next month. German Economy Minister Michael Glos agreed that Germany could ill-afford to make a priority of climate protection with the economy hobbled by the global financial crisis. And the conservative premier of Lower Saxony, Christian Wulff, also called for a two-year hiatus for the EU climate package.

On Nov. 25, the Environment Minister of the German federal state of Lower Saxony called for a delay of five to ten years in adopting the European union climate targets, because of the global financial and economic crisis.

"Yes things have changed," said Yvo de Boer, head of the United Nations Framework Convention on Climate Change, on Nov. 24. "European industry is saying we can't deal with financial crisis and reduce

Continued on page 82

Paulo Figueiras/UN Photo

Reality strikes German Chancellor Angela Merkel: Here, in September 2007, she was promoting emissions reductions at the U.N. climate conference. Now, she's worried about job losses.

A European Union climate poster. Now, heads of government have other things on their minds, said Yvo de Boer, head of the U.N. Framework Convention on Climate Change.

Human Creative Reason As a Fundamental Principle In Physics

by Sky Shields

Bring back the concept of cognition as an independent organizing principle in the universe!

Bernhard Riemann at work, as depicted by Basement team member Peter Martinson, in the LYM video "The Matter of Mind" (larouchepac.com/news/2008/12/15/lpactv-matter-mind.html), which elaborates the ideas in this article.

EDITOR'S NOTE

Lyndon H. LaRouche, Jr. commented in depth on this report in two articles published in the Oct. 17, 2008 issue of *Executive Intelligence Review,* which also featured Sky Shields's article. The LaRouche articles are "How the Human Mind Works (The Sight and Sound of Science" (www.larouchepub.com/eiw/public/2008/2008_40-49/2008-42 /pdf/15-19_4135.pdf), and "Why the Economists Failed: Economy & Creativity" (www.larouchepub.com/eiw/public/2008/2008_40-49/2008- 42/pdf/04-12_4135.pdf).

LaRouche wrote that "the emergence of the role of actual creativity within the work of the LaRouche Youth Movement, especially the 'basement operations,' is of the greatest significance for treating the crisis which menaces all of mankind at the present moment." The "basement" refers to the location in Northern Virginia of the LaRouche Youth Movement team examining Kepler and his scientific followers.

A 45-minute videotaped interview with Shields can be viewed at www.larouchepac.com/news/2008/12/11/lpac-tv-sky- sheildss-report-basement.html.

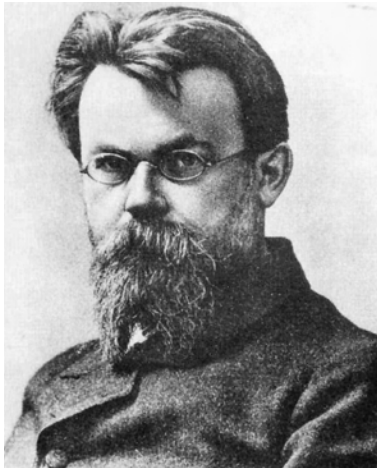
In the course of recent work preparing a translation of a piece by V.I. Vernadsky on the historical evolution of the concept of physical space-time (i.e., the concept that space and time as such do not actually exist, except as shadows of the physical processes which seem to occur within them), we encountered an interesting reference which may help in shedding further light on the ontological significance of the concept of *potential*, as investigated successively by Gauss, Dirichlet, Weber, and Riemann. Most significantly, it indicates avenues along which we may continue the same conceptual approach which Riemann took to this subject in his so-called philosophical fragments. The reference, taken from a 1931 written speech by Vernadsky entitled "The Problem of Time in Contemporary Science," runs as follows:

> Christian von Ehrenfels in Prague, a psychologist who is currently living, has pointed out, on the basis of study of the psychological life of the individual, a lawful, spatial manifestation in this domain, of phenomena which have long stood outside of scientific work. He has shown the necessity of recognizing certain geometric gestalts,

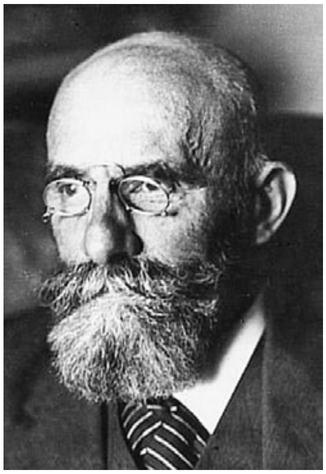
> or structures for visual space, for melodic tones and other similar types of phenomena connected with structure of the spatially and temporally identifiable cognitive apparatus. These notions of psychological gestalts were extended to phenomena of zoopsychology and physics by Berlin professor Wolfgang Köhler. They led to a new scientific expression of physical space and to an entirely new current in philosophy, studying the laws of cognition—to "Gestalt Psychology."

This reference by Vernadsky was curious for a number of reasons. First, because the thesis of the essay up until this point had been a demonstration that the concept of the unity of physical-space-time was not unique to Einstein's general relativity. This notion, he says, had existed already with the ancient Greeks, and it was only with Descartes, and then Newton, that the fallacy of absolute space and absolute time as independent, self-evident entities had been introduced. In Vernadsky's view, it was the work of physical experimentalists—in particular in this speech, he cites the experimental work of Pasteur and Faraday—which first began to force the necessity, in the modern period, of breaking from this Newtonian conception of empty space. He cites both Kepler and Leonardo da Vinci as conceptual predecessors to this break, because of their work on symmetry and the Golden Section, but oddly enough neglects to mention Riemann in this connection. Instead, he cites the mathematician William Clifford (who was responsible for the first English translation of Riemann's *Habilitationsschrift*), and it is in this context that he makes the mention above, regarding Ehrenfels, Köhler, and gestalt psychology. The idea that gestalt psychology represented a revival of the concept of a unified physical space-time was new to me, because of how little I knew about the subject. The fact that Vernadsky was following Köhler's work as a contemporary also struck me as interesting, so I decided to follow up on Vernadsky's reference.

I was happy to discover that, as Vernadsky implies in his quotes, Köhler's work on animal psychology was, for him, a secondary project which only resulted from the fact that Köhler was stuck on a research island full of apes for seven years because of the outbreak of World War I, and therefore had only apes as experimental subjects for those years. His original, and subsequent, work was on examining the human thought process, and in particular Classical artistic composition (he was noted for his dislike of Wagner). It was from this research that he derived his concept of the gestalt—the fact that the human mind operates solely on the basis of whole ideas, which are not composed of parts. The *organization* of the parts is itself a self-subsisting principle, independent of those parts. This represented a revival in modern form of Leibniz's monad, as applied to human cognition, and consequently it also represented a revival (whether Köhler himself was aware of this or not) of Riemann's Herbartian (i.e., Herbart's Leibnizian) concept of the "thought-object" (*Geistesmasse*), as presented in the philosophical fragments.



V.I. Vernadsky (1863-1945)



Christian von Ehrenfels (1859-1932)

Wolfgang Köhler (1887-1967)

In a 1931 speech, Vernadsky commented on the importance of psychologist Ehrenfels's recognition of geometric and psychological gestalts and their elaboration in psychology by Wolfgang Köhler. Vernadsky's remarks piqued author Shields's pursuit of the background involved, including Köhler's correspondence with his teacher, physicist Max Planck, whose work is discussed in this issue in an article by Caroline Hartman.

This alone would have been interesting enough, but the next item to deepen my curiosity considerably, was a reference by Köhler, in a 1959 speech titled "Gestalt Psychology Today," to discussions which he had engaged in with Max Planck. This reference occurred in the context of his discussing the tendency of physicists to mistreat their mathematical formulae:

> When reading the formulae of the physicist, one may emphasize this or that aspect of their content. The particular aspect of the formulae in which the gestalt psychologists became interested had, for decades, been given little attention. No mistake had ever been

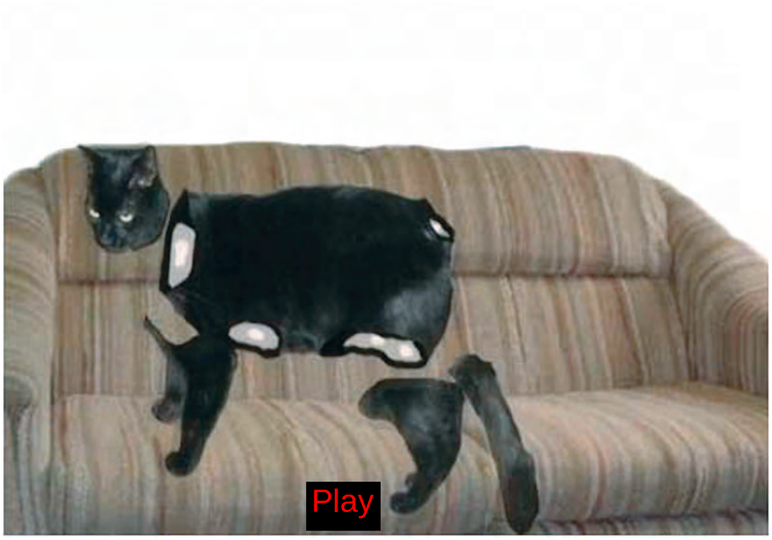
made in applications of the formulae, because what now fascinated us had all the time been present in their mathematical form. Hence, all calculations in physics had come out right. But it does make a difference whether you make explicit what a formula implies or merely use it as a reliable tool. We had, therefore, good reasons for being surprised by what we found; and we naturally felt elated when the new reading of the formulae told us that organization is as obvious in some parts of physics as it is in psychology.

Incidentally, others were no less interested in this "new reading" than we were. These other people were eminent physicists. Max Planck once told me that he expected our approach to clarify a difficult issue which had just arisen in quantum physics if not the concept of the quantum itself.

Again, this opened up a number of interesting avenues to pursue. Only four pieces of correspondence exist between Köhler and Planck, because most of their discussions occurred in person, while Köhler was Planck's student in Berlin, so it has been difficult to locate material containing the exact content of their discussions on this topic. But despite that, given the work that the LaRouche Youth Movement has already done on Kepler's *Harmony of the World*, it will not be hard for us to guess what the gist of those discussions must have been, as I'll discuss below.

First, however, more on the significance of Köhler's work to what we are now investigating in Riemann's works. In a footnote in Köhler's 1939 book, *Dynamics in Psychology*, in the context of discussing which fields of physics he thought would be most fruitful for investigations in gestalt psychology, he writes:

> Apart from physical chemistry and electrochemistry, the most important discipline which will have to be included in the list is *potential theory*, the theory of macroscopic self-distributions. Unfortunately this field shares the neglect in which many parts of Classical physics have fallen since atomic physics came into the foreground.



The human mind operates solely on the basis of whole ideas, gestalts, which are not composed of parts, and the organization of those parts is itself a self-subsisting principle, independent of those parts. Our cat illustrates this point.

Bernhard Riemann (1826-1866).

Johann Friedrich Herbart (1776-1841).

Library of Congress

Gottfried Wilhelm Leibniz (1646-1716).

*Riemann's concept of the "thought object" (*Geistesmasse *in his philosophical fragments, revived Herbart's view, which itself had revived Leibniz's conception of the monad, applied to human cognition.*

This reference was certainly a surprise, considering that I had not expected this side project to intersect with the work in which we are currently engaged in the Basement: investigating Riemann's work on potential theory in order to gain a better grasp of his application of Dirichlet's Principle to Riemann surfaces and the higher transcendentals, elliptical and Abelian functions. Suddenly, an aspect of the political significance of Riemann, Dirichlet, Gauss, and Weber's treatment of potential became clear. To explain this, some history of the concept is in order.

The Concept of 'Potential'

The mathematical expression which is popularly referred to as the potential function (though this name was only given to it later, by Gauss), and the differential expression now called the Laplacian, arose during Lagrange and Laplace's attempts to untangle the mathematical mess they created while attempting to apply Newton's inverse square law to the real universe—the three body problem in planetary perturbations. The ontological significance of potential, however, was denied by both Lagrange and Laplace in their attempts to cover up for the inverse square law, and was treated instead as an artifice—a useful tool for resolving a difficult problem of analysis. That this mathematical expression is, however, only the mathematical shadow of a principle, was a fact recognized by Gauss, Weber, Dirichlet, and Riemann. The actual ontological significance of potential goes back to (and is really identical with) Leibniz's concept of dynamics.

The fact that all processes in the universe must be conceived of as governed by universal principles which exist only as wholes, which have no component parts, is expressed in their physical manifestation by:

(1) the fact that universal physical principles, although themselves not existing at any specific point in space or in time, exist as though outside of but tangent to every point and every moment in a physical process, no matter how small a division of that process is taken (the ontological infinitesimal of Leibniz),[1] as well as

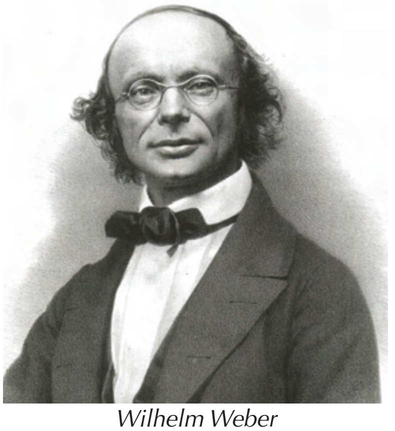
(2) the fact that the future state of any process is what governs its present (i.e., that intention exists as a governing principle in the universe).

These two facts combine to provide us with a notion of the ontological significance of potential, understood in the sense of Leibnizian dynamics. This concept of potential is exactly what Isaac Newton was created in order to attack—hence the notion, inserted into the famous scholium of his *Principia*, that "I don't frame hypotheses," really, as is clear from both that scholium, and Roger Cotes's introduction to that book, "the act of hypothesis is impossible, because in the universe only facts, not reasons are knowable."[2]

It is significant that Vernadsky makes exactly this point about Newton in

Johann Peter Gustav Lejeune Dirichlet (1805-1859).

Carl Friedrich Gauss (1777-1855).



Wilhelm Weber (1804-1891).

Dirichlet, Riemann, Gauss, and Weber all pursued the idea that universal physical principles govern the processes of the universe, and that the future state of any process governs its present. This Leibnizian concept of potential is the opposite of the Newtonian empirical view.

1. This is despite the reductionist's insistence, which is not validated by experiment, that an atom, say of carbon, within a living organism, is essentially the same in its internal characteristics as an atom of carbon outside of a living organism. I.e., that there exists no independent principle of life which cannot be reduced to non-living—abiotic—phenomena.

2. Cotes writes in this introduction, in response to Leibniz's observation that the idea of the "force" of gravity is an occult quality, and that the reasons for universal gravitation and the organization of the Solar System must be knowable:

"He who is presumptuous enough to think that he can find the true principles of physics and the laws of natural things by the force alone of his own mind, and the internal light of his reason, must either suppose that the world exists by necessity, and by the same necessity follows the laws proposed; or if the order of Nature was established by the will of God, that himself, a miserable reptile, can tell what was fittest to be done. All sound and true philosophy is founded on the appearance of things; . . . These men may call them miracles or occult qualities, but names maliciously given ought not to be a disadvantage to the things themselves, unless these men will say at last that all philosophy ought to be founded in atheism."

Joseph Louis Lagrange (1736-1813).

Lagrange and Laplace denied the significance of potential and instead created a mathematical formula to be used in calculations.

Posthumous portrait by Madame Feytaud, 1842

Pierre-Simon Laplace (1749-1827).

the speech with which we began this paper, including the point that Newton's views as popularly distributed were a product synthesized by both Cotes and Samuel Clarke in that edition of the *Principia*. Vernadsky states:

> It [the concept of the force of gravity] was introduced into scientific thought in 1713, in the foreword to the second edition of *Philosophiae Naturalis Principia,* a foreword written by Cambridge professor Roger Cotes, editor of this second edition, as one of the notions which could be logically connected with the mathematical results of Newton.
>
> Newton highly esteemed Cotes, who was soon to die young, but he, at least officially, never read his foreword.
>
> I can not here enter into an explanation of the reasons for this relationship of Newton to the appearance of an idea, which he always contradicted, in the foreword to his work. The idea, however, of universal gravitation, having placed its mark on all scientific thought of the following two centuries, was accepted as a consequence of the achievements of Newton—as a Newtonian idea.[3]

The approach taken by Gauss, Dirichlet, Weber, and Riemann therefore represented a counter-reaction to this attempted reduction of all physical phenomena to attraction and repulsion between hard balls.

We ourselves, in this current Basement team, initially became interested in Riemann's work on potential because of his treatment of the subject in his philosophical fragments. There, he himself draws an analogy between the processes of thought and the phenomena of gravitation, electricity, and magnetism—the three phenomena which may be mathematically represented by forces acting with an intensity of effect which is inversely proportional to the square of distance. In the context just laid out, this approach of Riemann, along with the fragments taken as a whole, takes on a significance to which Lyndon LaRouche has been repeatedly pointing in recent days—that the concept of potential understood ontologically is not a mathematical principle, although it has significant mathematical corollaries when applied to physical processes. It is, rather, necessary to study all three phase spaces of the physical universe, first and foremost the cog-

From a portrait by John Vanderbank, 1725

Isaac "I don't make hypotheses" Newton (1642-1727)

3. This same denial of the human capability for discovering truth, the source of the idea of absolute space and absolute time existing as *a priori* concepts, is what underlay Newton's fabrication of the occult idea of "force." As reported by Newton's successor in his mathematics chair at Cambridge, William Whiston:

"It will not be unfit also, with regard to myself, nor unuseful with regard to the Publick, if I take notice here, that during the time of my Acquaintance with Him [Newton], He did always own the impossibility of solving Gravity mechanically, because it was ever proportional to the *Solidity* of Bodies, and equally effectual in the very middle of solid Bodies, as on their superficial Parts: whereas all mechanical Powers act only on their *Surfaces*: and he seemed to me always firmly persuaded, that this *Gravity* was deriv'd from the immaterial Presence and Power of the Deity, as it pervaded all the solid Parts of Body, and operated on them all. . . .

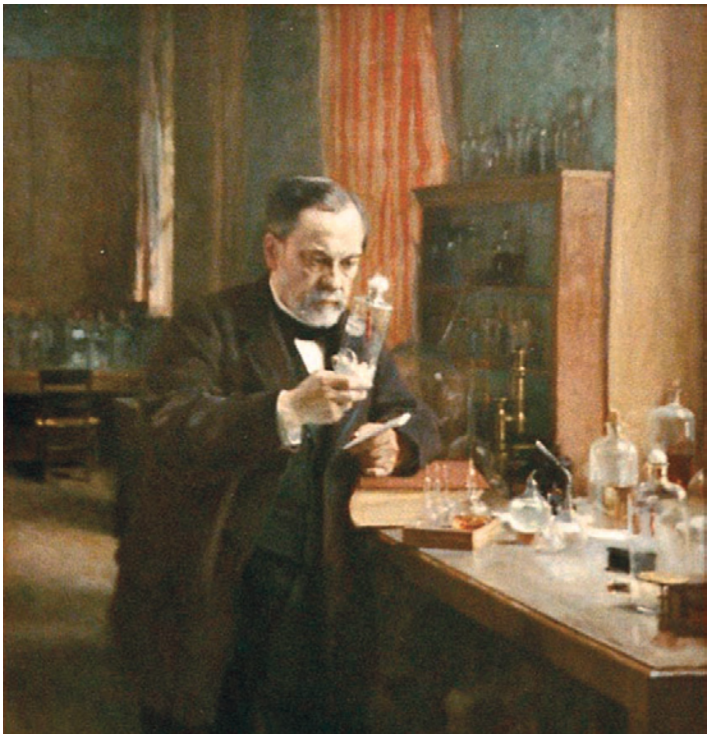
"I well remember also, that when I early asked him, Why he did not at first draw such Consequences from his Principles, as Dr. *Bentley* soon did in his excellent Sermons at Mr. *Boyle's Lectures*; and as I soon did in my *New Theory*; and more largely afterward in my *Astronomical Principles of Religion*; and as that Great Mathematician Mr. Cotes did in his excellent *Preface* to the later Editions of Sir *I.N.'s Principia*: I mean for the advantage of Natural Religion, and the Interposition of the Divine Power and Providence in the Constitution of the World."

nitive and the biotic, as independent principles of which the abiotic phenomena of electricity, magnetism, and gravitation are simply sub-processes. It is cognition which governs the world of phenomena, and cognition is best studied by a direct investigation of the human creative process in both science, and in Classical artistic communication of profound ideas.

It is significant to note that this was exactly the approach of Riemann in his so-called philosophical fragments. An examination of the original manuscripts of these fragments reveals that their classification into the separate categories given in Heinrich Weber's edition of *Riemann's Collected Works* was accomplished only by the removal (perhaps accidental, perhaps intentional) of certain key paragraphs which demonstrate that Riemann's investigation of thought objects (*Geistesmassen*), his study of potential, and his critique of Newton were all part of the same thought process.

A version of the fragments containing these missing paragraphs will be released soon. In the meanwhile, a study of the intellectual and social environment in which Riemann was immersed (detailed reports are forthcoming) ought to provide us a clearer picture of Riemann's influences in the area of human psychology and human creativity in general. These influences, as Riemann states in his philosophical fragments, gave rise to the method with which he approached these subjects of physical science, human creativity, and the higher transcendentals. His description of the phenomena of gravity, electricity, and magnetism, taken from those fragments goes as follows:

> Thought is a process within ponderable matter. Our external experience, the facts of our external perception, which must find their explanation in the processes within ponderable or gravitating matter, are
>
> 1. universal gravitation
> 2. the universal laws of motion.
>
> Something lasting underlies each act of thought, something which, however, is manifested only under the specific occasion of memory as such, without exerting any enduring influence upon phenomena. Therefore with each act of thought, something lasting enters our soul, something which exerts no enduring influence upon phenomena.
>
> On the other hand, our external experiences about ponderable matter can be explained if it is assumed that a homogenous substance fills the whole of infinite space, and constantly flows into ponderable matter and vanishes.[4]



From a painting by A. Edelfeldt, 1885

Louis Pasteur (1822-1895). Pasteur's experimental work forced a break with Newton's idea of empty space.

We are already familiar with this method—of taking the principles of human creativity as primary—from our study of Kepler's *Harmonies*. The study of harmonics as presented there, and as expressed in the organization of the Solar System, exists only if the uniquely human concept of beauty is treated as a self-evident, experimentally validated fact, independent of the abiotic

Kepler understood that the concept of harmony guided the organization of the Solar System as a whole.

4. www.wlym.com

Leonardo da Vinci (1452-1519), in a self portrait.

Johannes Kepler (1571-1630), in a 1630 portrait.

Both Leonardo and Kepler understood the principle of human creativity as primary. Unlike Newton and his slavish empiricist followers, they also understood that space was not empty.

phenomena which mediate its expression at any given time. As Kepler demonstrates, the concept of harmony as it is expressed in the Solar System—although it agrees with expressions in geometry and elsewhere—is neither derivable from them nor reducible to them. This concept of harmonics, not capable of investigation outside of an investigation of the creative human individual, is what is then applied, directly, as the principle which guides the organization of the Solar System as a whole.

From this, it is clear that the concept of potential, as a unified process governing the apparent forces of universal gravitation, was already recognized as a principle cognate with that of human creativity at its inception, with the scientific work of Johannes Kepler. This methodological approach to potential was continued in the work of Leibniz on dynamics, and in the work of Gauss, Dirichlet, Weber, and Riemann on attempting to undo the damage done to science by Newton's religious dogma.

In that context, I can feel comfortable including a rather lengthy citation from Köhler, which, despite certain shortcomings in other respects, does give some insight into the political fight around scientific method in which he and Planck were engaged during the first half of the 20th Century, as well as into possible avenues of investigation for us to take up today, respecting the ontological significance of Dirichlet's principle and the concept of potential. Taken from his *The Place of Value in a World of Facts*, it reads:

> Experimental physics is not particularly interested in the study of such continuous macroscopic states. As the conditions under which self-distribution may be varied freely, an infinite number of macroscopic states is possible in each class: the hydrodynamic, the electric, and so on. The investigation of a number of individual cases would add little to our knowledge of basic physical facts. Besides, what could the experimentalist do? In order to know the distribution of a steady current inside a given volume he would have to measure the rate and direction of flow at as many points as possible—a thoroughly tedious occupation. At the same time this task would be awkward enough, since, at least in many cases, the very attempt to measure local flow will lead to interference with the distribution itself: The approach and the insertion of a measuring device would generally mean the introduction of new conditions to which the macroscopic state can respond only by a change of distribution. Satisfied that no essentially new facts are to be discovered in this field, the physicist will moreover give little time to macroscopic states in his teaching. This is why one can learn a good deal about practical physics without ever hearing much about this section of science. As a matter of fact, the investigation of self-distribution in continuous media has become a task for mathematicians rather than for physicists. The general rule which macroscopic states must fulfill is easily formulated in mathematical terms. A single differential equation, named after Laplace,

Author Sky Shields in a video grab from an interview in which he discusses the ideas in this article. The 45-minute interview can be viewed at www.larouchepac.com/news/2008/12/11/lpactv-sky-sheildss- report-basement.html.

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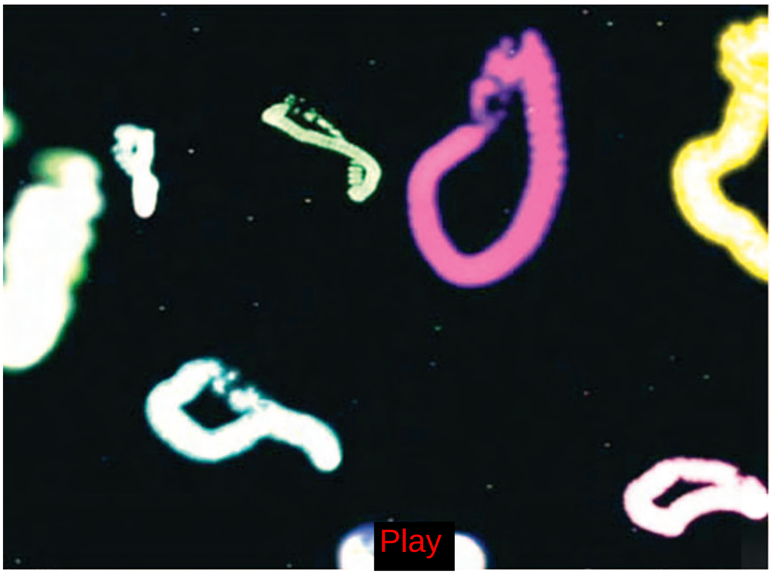


Human creativity (above) vs. statistical gobbledeygook: "Our task as a movement must be to revive actual human creativity as a matter of practice, and to make this revival the basis upon which we, as a culture, find our way out of the mess into which we've gotten ourselves over these recent decades."

will apply to most cases. Unfortunately, however, this equation does not express much more than that in a steady state the forces and the flow at each point should not alter this steady state. Just what distributions would, as a whole, correspond with this condition in a given case is the question which the mathematician tries to answer. No direct and simple mathematical procedure is available for this purpose. During the 19th Century the invention of solutions for even comparatively simple cases occupied some of the best mathematical minds. The Dirichlet problem and the Neumann problem, formulations of this mathematical task for two slightly different sets of conditions, are noted for their tremendous difficulty. . . .

This is not a branch of physics with which other men of science, philosophers and the public will become familiar through popular books. If they did, the belief would not be so general that physics is under all circumstances an "analytical" science in which the properties of more complex extended facts are deduced from the properties of independent local elements. The thesis that analysis, at least in this sense, does not apply to macroscopic dynamic states is borne out by the predicament of mathematicians who must find the steady distribution as a whole if they are to tell us what the steady flow is in a part of the system.

Our task now is clearly to further this conceptual approach to science and art. The concept of the human mind—cognition—as an efficient, independent organizing principle in the universe has been lost, in many cases intentionally eliminated, and that loss has brought humanity to a series of conceptual dead-ends. Science struggles between mindless statistical models and an equally mindless determinism; artistic expression has been reduced to the simplest expression of debased emotional states; and the organization of human society has merged both of these disasters to create the greatest abomination of them all: an economic system which blends the mindless mathematics of statistics with the irrational rule of utterly undeveloped human emotions—free trade.

All of this is now collapsing, and we have reached the point where human society can progress no further while maintaining the presently popular forms of belief in science and culture. Our task as a movement must be to revive actual human creativity as a matter of practice, and to make this revival the basis upon which we, as a culture, find our way out of the mess into which we've gotten ourselves over these recent decades. Economics must again become the science of human progress, on the basis of human creativity.

Sky Shields is a leader of the LaRouche Youth Movement in Los Angeles, currently working on the "basement" team.

On the 150th Birthday of Max Planck:

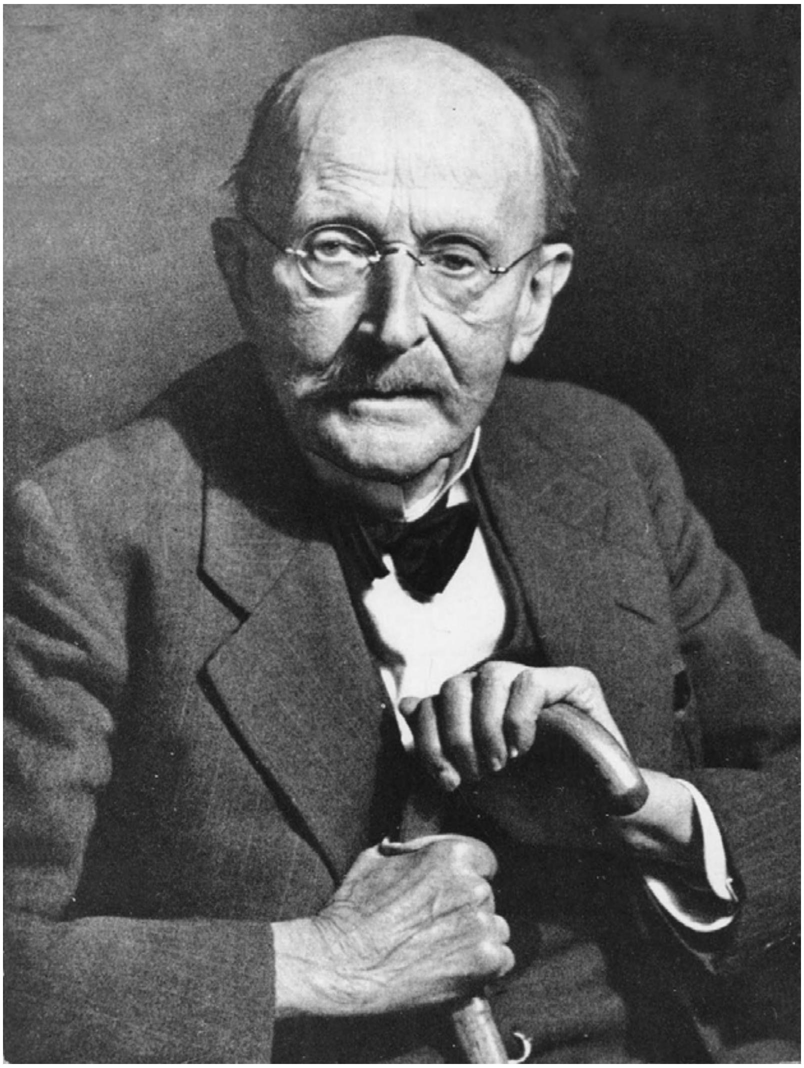
On Honesty Towards Nature

by Caroline Hartmann

Nature and the universe act according to lawfully knowable rules, not by the accidents of statistics and probability.

The great physicist Max Planck would have been 150 years old on April 23, 2008. In discovering the correct equation for the description of heat radiation (the famous Radiation formula), he blazed a new trail for physics. His formula contains the postulation $E = h\nu$, that is, that energy is available in so-called quanta. It is thanks to Planck's integrity and strength of character that this true explanation of heat radiation prevailed, because the discussion at that time was anything but honest, above all when one considered the methods of a Niels Bohr. For, the Copenhagen interpretation, the uncertainty principle, and quantum mechanics are pure mathematical-statistical interpretations. Almost all scientists at the time fell in with the mathematical euphoria, without exact knowledge of the true physical processes. First one had to have a System, then came the discoveries.

Already as a young physicist Max Planck had found that the world of established, so-called classical, physics, as represented by famous "big-name" professors like Robert Clausius, Hermann von Helmholtz, and others, suffered from some problems with the understanding of various natural phenomena, and above all with the acceptance of new and far-reaching ideas. In his prize-winning work of 1887, "Das Prinzip der Erhaltung der Energie" (The Principle of the Conservation of Energy), submitted for a contest sponsored by the Göttingen philosophy department, Planck had mentioned the work of Robert Mayer, the discoverer of the mechanical equivalent of heat, and especially his explanation of the phenomenon of heat.



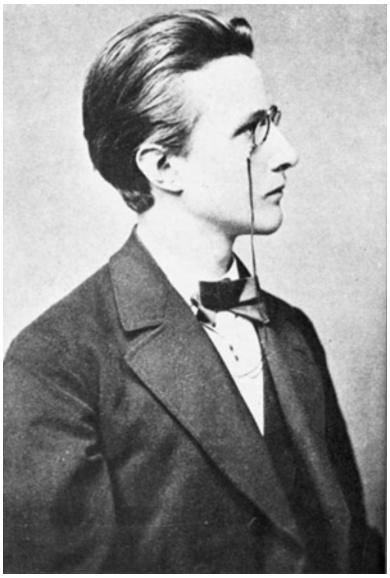
Presse- und Informationsamt der Bundesregierung-Bundesbildstelle

Max Planck (1858-1947)

Nature and the universe act according to lawfully knowable rules, not by the accidents of statistics and probability.

Heat is usually falsely explained as accelerated molecular motion of matter or bodies, that is, heat energy is a pure mechanical kinetic energy. Robert Mayer, who grappled intensively with the phenomenon of *vis* (*kraft*), had expressly noted in his discovery that heat, which is a kind of *vis* (today one says *energy*), is equivalent to the mechanical motive force, however, that this "heat energy" (*Wärmekraft*) ought not be expressly reduced to the increased motion of the smallest existing part of matter.[1]

A purely "mechanistic" explanation of heat would be impermissible and unfounded, according to Robert Mayer. That is also the point that Planck stressed throughout his life. Mayer's discovery pointed to concepts far into the future of this new field of physics, *thermodynamics,* but the then leading figures in physics, Hermann Helmholtz and Robert Clausius, reduced them to a purely "mechanistic" interpretation of heat phenomena and simply imported the already known laws of mechanics into the molecular domain. Thus began the dilemma over the fundamental understanding of Nature, which would break out anew after Planck's discovery.



Planck in 1878, the year he wrote his doctoral thesis in less than four months.

Julius Robert von Mayer (1814-1878) argued against a mechanistic explanation of heat. His discovery of the mechanical equivalent of heat was deliberately not acknowledged by Helmholtz.

Max Planck was born in Kiel on April 23, 1858. By 1867, the family had relocated to Munich, where the father was appointed professor of law at the university. His mother came from a family of ministers. His great-great grandfather Gottlieb Jakob Planck (1751-1833), Professor of Theology at Göttingen University, belonged to the circle of Abraham Gotthelf Kästner who brought Benjamin Franklin to Göttingen in 1766, and published the first translation of Leibniz's answer to John Locke's misanthropic theory, the *New Essays on Human Understanding.* The thinking of that great philosopher and mathematician also shaped Max Planck himself.

After graduation from high school, Planck studied in Munich for three years, and another year in Berlin under Helmholtz and Kirchoff. Concerning Helmholtz he reported:

> Sadly I must admit that his lectures brought me no appreciable advantage. Helmholtz obviously never prepared properly; he spoke only haltingly, picking out the needed data from a little notebook, besides consistently miscalculating at the blackboard, and we had the feeling that he was at least as bored by his presentation as we were.

Oil portrait by Ludwig Knaus, 1881

Hermann von Helmoltz (1821-1894). As a teacher, Planck said, Helmholtz was ill-prepared and boring.

In 1878, the just 20-year-old Planck wrote his doctoral thesis in less than four months. And after intensive study of the vastly different works on thermodynamics, for example that of Robert Clausius and Robert Mayer, he wrote the aforementioned essay, "The Principle of the Conservation of Energy," where he challenged the narrowly conceived notion of heat based purely on motion. Planck was firmly convinced that Nature and the universe acted according to determined rules, which are lawfully

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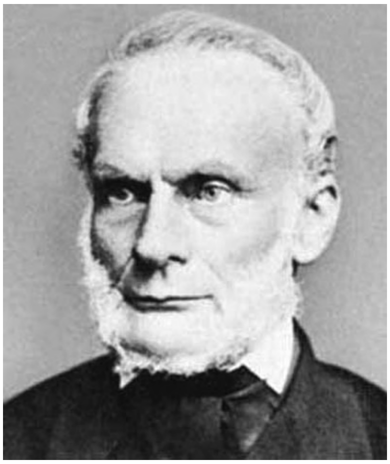
1. See also, "Was ist Wärme? Oder: warum die Natur keine Disco ist," (What Is Heat? Or Why Nature Is Not a Disco) in *Neue Solidarität*, Nos. 17 and 18, 2006).



Rudolf Clausius (1822-1888). Planck fought Clausius's contention that there is a continual increase in universal entropy, which became known as the Second Law of Thermodynamics.

knowable to man, not by the accidental whims of statistics and probability.

After his first years at the University of Kiel, in 1889 Planck was asked by the Berlin Philosophical Faculty to become the successor to Gustav Kirchoff (1824-1887) in the post of theoretical physics. In 1894, he was nominated to the Prussian Academy of Sciences. In the following year, he plunged into research aimed at widening the reach of thermodynamics. He subjected to fundamental questioning the mechanistic interpretation of heat advocated by Herman Helmholtz who, incidentally, in his 1847 writing "Über die Erhaltung der Kraft" (On the Conservation of Force), never mentioned Mayer's priority of publication of the discovery of the heat equivalent. Planck wrote:

> It is worthy of note, that with the discovery of the mechanical equivalent of heat and the development of the general principle of the conservation of energy, the belief that all natural phenomena consist in motion, went hand in hand and became virtually identical with it. Yet strictly speaking, the principle of the conservation of energy expresses no more than the convertibility of particular natural forces into one another according to fixed relationships, but sheds absolutely no light on the way in which this conversion takes place. It is in no way permissible to deduce from the applicability of the principle of conservation of energy, the necessity of the mechanical view of nature, while conversely, the principle of conservation of energy always emerges as a necessary result of the mechanical view, at least when one proceeds from central forces.

Max Planck was the sort of person who could never attribute an evil motive to another, so long as the contrary was not proven. He was, however, aware of the abstruse arguments of a Helmholtz or Lord Kelvin, who, from precisely this mechanistic world view, had taken for granted the ultimate "heat death" of the universe as a consequence of entropy. Planck was also well aware of the not very scientific habit of Helmholtz of routinely selling the works and ideas of others as his own. Throughout his life, Planck fought the conclusion which Robert Clausius had drawn from this overly narrow view of natural phenomena—namely, the theorem that there exists a continual increase in universal entropy (known as the Second Law of Thermodynamics):

> This hypothesis demands special comment. For, it should not only be expressed by this hypothesis that heat does not flow directly from a colder into a warmer body, but also that it is in no way whatsoever possible, to get heat out of a colder body into a warmer one, without some alteration in nature remaining behind as compensation.

Such an instance, namely "the process of heat conduction being in no way whatever completely reversible," Planck accepts as a matter of course; today it has become accepted under the concept of irreversibility. However, a fundamental difference is lurking here; the failure to recognize it has had a negative impact on the entire further development of the understanding of heat phenomena. Planck wrote:

> However, the error committed by an overly narrow interpretation of Clausius's theorem, and which I have fought against tirelessly for my entire life, is, it seems, not to be eradicated. For, up to the present day, instead of the above definition of irreversibility, I have encountered the following: "An irreversible process is one that cannot run in the reverse direction." That is not adequate. For, at the outset, it is well conceivable that a process which cannot proceed in the reverse direction, by some means or another can be made fully reversible.

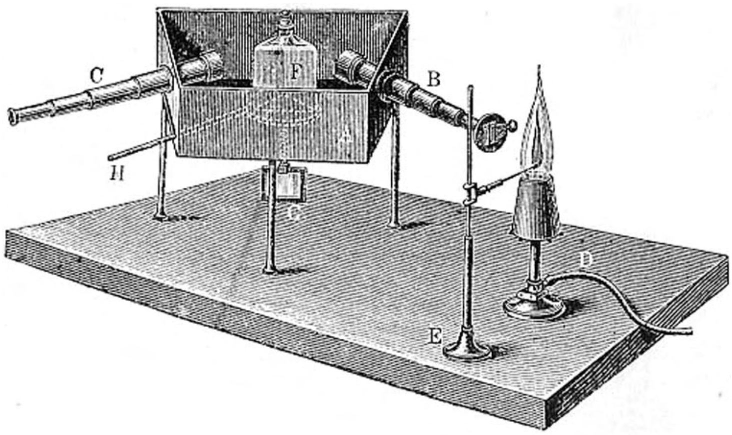
The more detailed investigation of heat, alongside the understanding that all radiation derives from the same process, and the various types are differentiated only by their frequency—postulated by Ampère, and then formulated as a law by Gustav Kirchoff—should have brought this mistaken and overly narrow conception into focus again. Unexpected and phenomenal discoveries in the investigation of the spectra of radiating bodies pointed to a certain constant regularity in the microscopic realm of the atomic construction of matter.

What Is Heat Radiation?

At the beginning of the 19th Century, the prevailing view still was that the various types of radiation were completely different as regards their refrangibility and other properties. There was visible light, which could be seen coming from the Sun or other glowing bodies; pure heat rays, which could be felt emanating from heated bodies, for example, a hot iron bar; and the chemically active rays (ultraviolet rays). Practically, in order to account for the natural phenomena, one started out from the human sensory impressions. However, to be able to find the real processes at play, one must look beyond these phenomena. That was done by the French physicist André-Marie Ampère, who asserted:

Experimental physicists Gustav Kirchoff, (1824-1887), left, and Robert Bunsen (1811-1899). Their work investigating the spectra of radiating bodies provided more evidence that the mechanists' narrow interpretation of Clausius's theorem was wrong.

Kirchhoff's first spectroscope. Using the famous Bunsen burner, Kirchoff and his collaborator Robert Bunsen discovered cesium, which gave off a characteristic blue flame, and rubidium, which gave off a red flame. A small quantity of the substance is placed on the wire suspended from the column E and swung into the flame. The light given off passes through tube B, and is dispersed by the prism F producing a unique rainbow of color which is examined through the small telescope C. Each element gives off its own characteristic bands of color. Below is a solar spectrum, produced by passing sunlight through a prism.



One and the same process must lie behind all the various types of radiation. For, light rays must be nothing other than visible heat rays, and the chemically active rays just heat rays of a higher frequency. That means that the types of radiation are distinguished only by their wavelength (frequency $\nu = 1/\lambda$), and one can arrange them into a continuous spectrum.

Our eyes, says Ampère, can only perceive a specific region of the spectrum as light, while they do not react to rays of other refrangibility. This insightful hypothesis emerged over time as the true one; however, it took a long time before it was proven that the radiation spectrum was actually continuous, i.e., that at every wavelength there existed a measurable radiation. Experimental physicists, including such investigators as Gustav Kirchoff, Robert Bunsen, Ernst Pringsheim, and Otto Lummer, concerned themselves with the trailblazing discoveries which ultimately led to Planck's discovery of the true law of radiation, and to a completely new understanding of physics.

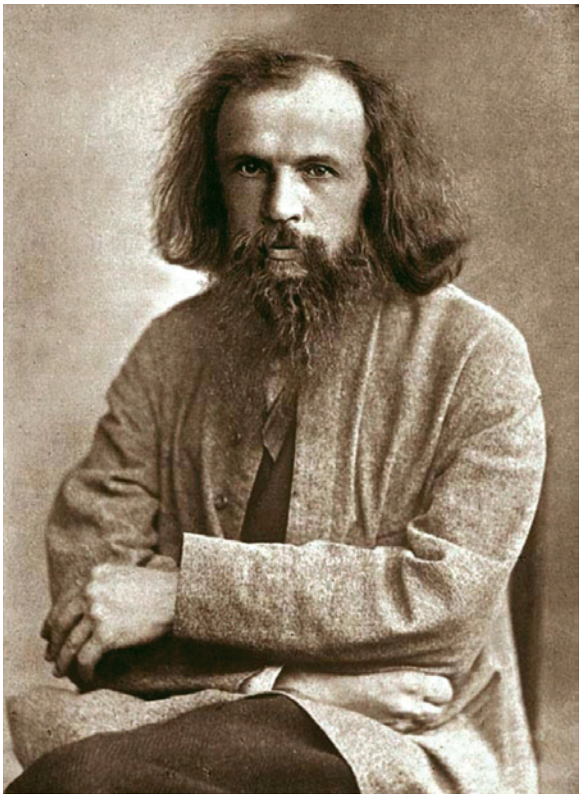
With "Bunsen's Lamp" (today known as the Bunsen burner), these scientists examined the spectrum of all kinds of materials, and came upon a completely unexpected phenomenon, which Kirchoff described in his publication "Über das Verhältnis zwischen dem Emissions- und Absorptionsvermögen der Körper für Wärme und Licht" (On the Relationship between the Ability of Bodies to Emit and Absorb Heat and Light):

If a definite body, a platinum wire, for example, is heated until it attains a certain temperature, it will emit—up to a certain temperature—only rays of wavelength greater than the visible rays. At a certain temperature, rays of infrared wavelength begin to appear; as the temperature rises higher and higher, rays

André-Marie Ampère (1775-1836). Ampère's work suggested that the radiation spectrum was continuous, and that the same process was behind all the various types of radiation.

of smaller and smaller wavelength are added, such that at each temperature rays of a corresponding wavelength appear, while the intensity of the rays of longer wavelength may grow. . . . It follows from this . . . that all bodies, when their temperature is gradually raised, begin to emit, at the same temperature, rays of the same wavelength, and thus begin to glow red at the same temperature, and at a higher temperature, they all begin to give off yellow rays, and so forth. The intensity of the rays of given wavelengths, which different bodies emit at the same temperature, can however be very different. . . .

How should this be explained? It can only have to do with the inner construction of matter.



Dmitri Mendeleyev (1834-1907) argued that there was a periodicity in the atomic weights of the elements, and his harmonic arrangement of the elements is what we today call the Periodic Table.

At the same time, a man by the name of Mendeleyev fought for his hypothesis in Russia, that there is a periodicity in the atomic weights of the elements. Amidst the general clutter of matter, he asserted, mass is not a simple linear function, but shows a harmonicity when the elements are arranged according to what we know today as Mendeleyev's periodic table. By 1860, a few years before Mendeleyev's great discovery, just 60 elements were known. The work of Kirchoff and Bunsen in corroborating Mendeleyev's thesis was of fundamental significance, and it is not surprising that they discovered two new elements (cesium and rubidium) through spectral analysis of the mineral water from Bad Dürkheim.

To better investigate these phenomena, which appear repeatedly in the same way in all matter, Kirchoff conceived of the ideal possibility of collecting all the rays at the same time in a closed cavity (*Hohlraum*), a so-called black body. That could be, for example, a metal pipe, which is painted black to minimize the escape of radiation, and to thus obtain an equilibrium condition among the reflecting and refracting waves within the body. The pioneering discovery of the year 1900, which showed that the energy is always partitioned in exactly the same way among the different wavelengths, independently of the character of the material, was published by Lummer and Pringshiem in the *Proceedings of the German Physical Society* under the title "Über die Strahlung des schwarzen Körpers für lange Wellen" (On the long-wave radiation of black bodies). This characteristic energy distribution of the radiation was completely incomprehensible from the standpoint of the prevailing understanding of the wave behavior of light. Planck described it as follows:

Imagine a body of water on which strong winds have generated high waves. After the wind stops, the waves will persist for some time and roam from shore to shore. However, they will experience a certain characteristic alteration. Especially as a result of their impact against the shore or other fixed objects, the kinetic energy of the longer, larger waves will be increasingly changed into the kinetic energy of shorter finer waves, and this process will persist until, finally, the waves become so small, and their motion so faint, as to become imperceptible. Hence, the well-known conversion of macroscopic into molecular motion, and ordered motion into unordered. For, in ordered motion, neighboring molecules share a common velocity, while in the disordered, each molecule possesses its own, peculiarly directed velocity.

However, the process of splitting up (scattering) described here does not go on indefinitely, but finds a natural limit in the size of the atom. For the motion of a single atom, taken by itself, is always ordered, since the individual parts of an atom all move with the same common velocity. The larger the atom, the smaller can be the splitting up of the total kinetic energy. So far it is all perfectly clear, and the classical theory best corresponds with experiment.

Now let us think of a completely analogous process—not with waves of water but of light and heat radiation—and assume, for example, that by provision for adequate reflection, the rays emitted by an intensely heated body would be collected within an enclosed cavity (*Hohlraum*), and constantly thrown back and forth between the reflecting walls of the cavity. Here also, a gradual transformation of the radiant energy from longer to shorter waves, from ordered to disordered, will take place; the longer, larger waves

Planck worked intensively to find an explanation of fundamental processes in the universe, as shown by the fixed natural constants found in experiments with heat radiation. When he succeeded, the physics mafia fought against his concept of the quantum of action.

> correspond to the infrared, the shorter, finer to the ultraviolet part of the spectrum. According to the classical theory, one would expect that the whole radiant energy finally ends up in the ultraviolet part of the spectrum, or, in other words, that the infrared and visible rays gradually disappear altogether, and are changed into the invisible ultraviolet rays which evince predominantly only chemical action.
>
> However, no trace of any such phenomenon can be found in Nature. In fact, the transformation sooner or later becomes completely determined, in a precisely detectable end result, and from thence the condition of the radiation remains stable in that respect.[2]

These results gave evidence of a constant relationship, and Planck, firmly convinced that an explanation of fundamental processes in the universe could be found from these fixed natural constants, worked intensively for a solution:

> From the experimental measurements of the spectrum of heat radiation made by Lummer and Pringsheim at the government Physical-Technical Institute, my attention was directed to Kirchoff's theorem, that in an evacuated cavity surrounded by perfectly reflecting walls and containing any emitting and absorbing body whatsoever, over time a condition is reached, in which all bodies take on the same temperature, and the radiation in all its properties, including the distribution of its spectral energy, depends not upon the character of the body, but only upon its temperature. This so-called normal energy distribution thus represents something absolute, and as the search for the absolute always seemed to me to be the most beautiful problem to research, this examination became my passion.

Is Nature Based on Statistical Accidents?

The formula, which Planck ultimately discovered, implied the condition $E = h\nu$, which states that matter can only absorb energy in determined portions (*quanta*). Thus did the old debate, whether radiation consisted of waves or particles, blaze up again. Planck was somewhat shocked by the fireworks he had set off in physics, and had to assert that there were still too few facts, and also too few physicists who appreciated the necessity for an urgent reform of so-called "classical physics." And facts could ultimately only be gotten by experiment:

> My futile attempts to incorporate the Quantum of Action into classical physics extended over a number of years, and cost me much work. Many colleagues

Hendrik Antoon Lorentz (1853-1928)

Walther Nernst (1864-1941)

Lorentz and Nernst organized the Belgian industrialist Ernest Solvay to fund a conference to promote an establishment consensus that would exclude consideration of the more controversial aspects of Planck's challenge to classical physics.

2. From the lecture "New Paths in Physical Knowledge," delivered by Planck on Oct. 15, 1913, on the acceptance of his Rectorship of the Friedrich Wilhelm University in Berlin).

Benjamin Couprie, 1911

The 1911 Solvay Conference brought together leading physicists and produced a foul compromise, squeezing natural processes into the acceptable mathematical straitjacket, supplied by Niels Bohr.

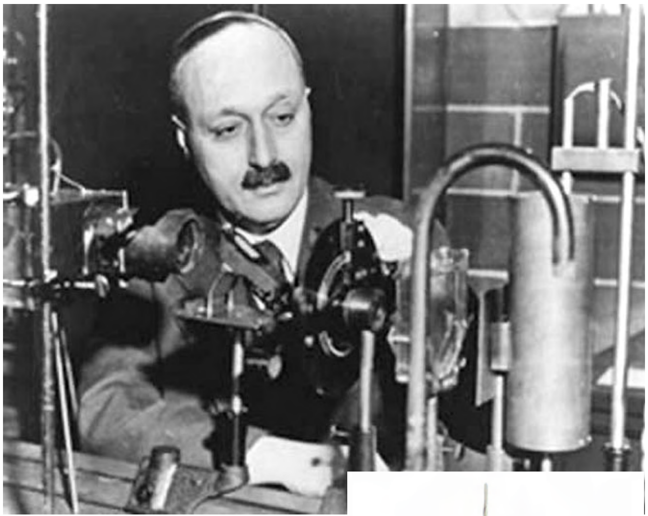
Seated (from left): Walther Nernst, Marcel Brillouin, Ernest Solvay, Hendrik Lorentz, Emil Warburg, Jean Baptiste Perrin, Wilhelm Wien, Marie Curie, and Henri Poincaré. Standing (from left): Robert Goldschmidt, Max Planck, Heinrich Rubens, Arnold Sommerfeld, Frederick Lindemann, Maurice de Broglie, Martin Knudsen, Friedrich Hasenöhrl, Georges Hostelet, Edouard Herzen, James Hopwood Jeans, Ernest Rutherford, Heike Kamerlingh Onnes, Albert Einstein, and Paul Langevin.

> saw in that a kind of tragedy. I am of another opinion, for the benefit that I got from such fundamental investigation was the more valuable. Now I knew for sure that the Quantum of Action played a very important role in physics, just as I had been inclined to assume from the start.
>
> However, precisely the existence of a kind of objective limit, as is represented by the elementary quantum of action, must be judged as evidence for the rule of a certain new kind of Lawfulness, which certainly cannot be ascribed to statistics. Clearly nothing was left but the admittedly very radical, but obvious, assumption, that the elementary concepts of classical physics no longer suffice in atomic physics.

Planck was already familiar with the attitude of people like Helmholtz and Clausius toward fundamental questions of physics, based as it was on vanity and the desire for fame. However, what now took place exceeded both personal craving for recognition and dogmatism; it was conscious sabotage of the search for truth. The Swedish Academy appealed to the authority of Hendrik Antoon Lorentz (1853-1928), professor of theoretical physics at the University of Leyden, who was admired as one of the greatest physicists. He made clear at the start that Planck's formula lacked a satisfactory theoretical basis, and he authored a demonstration that Planck's formula was not derivable from classical physics, and therefore could not be right. Thus he lectured in April 1908, at a mathematical congress in Rome.

However, as it became clear that Planck's formula could no longer be ignored, Lorentz and Walther Nernst (1864-1941), among others, got the rich Belgian industrialist Ernest Solvay to fund an urgently necessary conference to reach agreement among scientists that the existing worldview of classical physics must not be attacked.

The "solution"—i.e., a foul compromise—was supplied by Niels Bohr with help of the young mathematical genius Heisenberg. The characteristic of this matrix mechanics (as Max Planck called it), was that real natural processes must be made to fit a well-functioning mathematics. The situation recalled the dilem-



National Archives and Records Administration of the United States

James Franck, the German chemist who later emigrated to the United States and worked at the University of Chicago, where he was a close collaborator of Dr. Robert Moon. In 1913, Franck and Gustav Hertz conducted one of the first experimental demonstrations of Planck's principle of quantization. Inset is a three-electrode tube of the type Franck and Hertz used. The work required to excite the mercury vapor contained in the tube to resonance, is the product of the frequency of the mercury resonance line into Planck's constant h.

ma of the 16th Century, respecting the understanding of the motion of the heavenly bodies. Before Johannes Kepler's precise investigation of the orbit of Mars in his *Nova Astronomia,* and his discovery of the true law of motion (which implicitly contained within it the natural constant of gravitation), there was just confusion among the different "models," none of which had anything to do with the actual processes of Nature. Planck was conscious of the positivist and sophistic mindset, which always led into a deeper dilemma.

Later, as he became active in opposition to the Nazis, Planck noted Kepler's belief in something *transeunt* over science, which drove him to say—in spite of the mathematically astonishingly correct results of the "models" of Ptolemy, Copernicus, and Brahe: All models are false, and I will find the truth:

> Can such a deeper conception of science be the basis for a guiding philosophy to live one's life by? We find the surest answer to this question by looking back in history to the men who embraced such a conception of science as their own, and for whom it indeed served this purpose. Among the numerous physicists, for whom their science helped them endure and ennoble a miserable life, we remember . . . in the first rank . . . Johannes Kepler. Outwardly, he lived his life under beggarly conditions, disappointment, gnawing hunger, constant economic pressure. . . . What kept him alive and able to function through it all was his science, but not the numerical data of the astronomical observations in themselves, but his abiding faith in the power of a lawful intelligence in the universe. One sees how significant that is in a comparison with his employer and master Tycho Brahe. Brahe possessed the same scientific knowledge, the same observational data, yet he lacked the faith in the great eternal laws. Thus Tycho Brahe remained one among many worthy investigators, while Kepler was the creator of the new astronomy.

The mathematical "wunderkind" Heisenberg flunked the physics course under Professor Kirchoff, because he had no understanding of experimental physics. But in spite of this, he got powerful back-up from the Bohr faction for his development of Quantum Mechanics. This "solution" was given detailed philosophical justification through the "uncertainty principle" at the so-called "Bohr festivals" in Göttingen—as Bohr's chatty lectures were called.

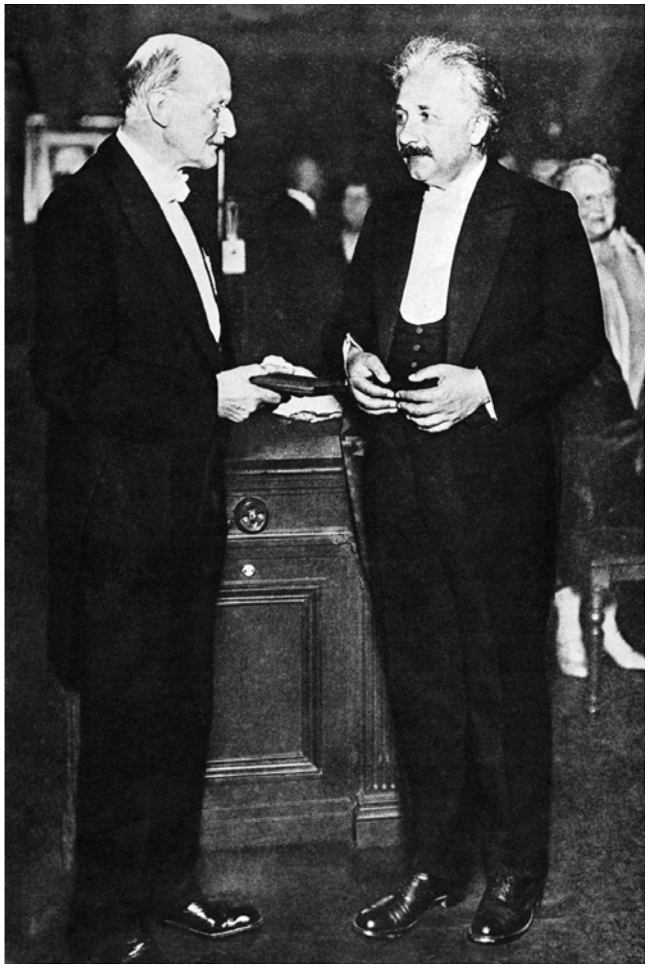
Einstein: God Does Not Play Dice!

In 1894, Planck was admitted to the Prussian Academy of Sciences. Here he attempted to extend thermodynamics to other conditions, and thereby to delimit the Clausius entropy principle, as "it is completely unfounded, simply to assume that changes in Nature always proceed in the direction from lesser to greater probability." When Planck was chosen in 1912 alongside Wilhelm Waldeyer as one of the standing members of the physical-mathematical group in the Prussian Academy, and in 1913 as Rector of Berlin University, he soon made an

Werner Heisenberg (1901-1976) around 1927. His frank account of a 1926 discussion with Einstein highlights the difference between a mathematics and truth.

Paul Ehrenfest

Albert Einstein (left) and Niels Bohr in Brussels at the 1930 Solvay Conference.



Max Planck presents Albert Einstein with the inaugural Planck medal, in Berlin in June 1929.

effort to bring Albert Einstein to Berlin as theoretical physicist, because he admired his work on Relativity Theory and, above all, his rigorous honesty on fundamental questions of natural knowledge. Planck's first official act consisted in the creation of a second chair of theoretical physics, which he offered to Einstein as a distinguished professor.

Symptomatic of the fundamental errors of the Bohr-Heisenberg type of "mathematical" analysis of Nature, which is, for all intents and purposes, a self-deception, is a discussion between Einstein and Heisenberg in the Spring of 1926 in Berlin, after Heisenberg had presented his new mathematics for the first time at the University of Berlin. After the colloquium, Einstein asked Heisenberg for a fuller discussion, which Heisenberg later gave an account of in his Notes (pp. 92-95) *Der Teil und das Ganze* (The Part and the Whole):

> But as we were entering the apartment, he opened up the conversation at once with a question, which went straight to the philosophical assumptions of my research: "What you have just told us, is very exceptional. You assume that there are electrons in the atom, and there you certainly are correct. However, the paths of the electrons in the atom, these you want to abolish completely, although one can still directly observe the electron tracks in a cloud chamber. Can you explain to me somewhat more precisely the reason for these remarkable assumptions?"
>
> "The paths of the electrons in the atom cannot be observed," I replied, "however the radiation, which is emitted from an atom during the process of relaxation, can be inferred directly from the frequency of oscillation and the associated amplitude of the atomic electron. In present-day physics, the complete knowledge of the frequency and amplitude serves as something like a surrogate for knowledge of the electron paths. But as it is still reasonable in a theory to assume only the magnitudes which can be observed, it seems to me natural to introduce these only, as representatives, so to speak, for the electron orbitals."

> "But you don't really believe that one can assume only observable quantities in a physical theory," Einstein countered.
>
> "I thought," I asked amazed, "that you had directly applied such thoughts to the foundations of your relativity theory? You had stressed that one should not speak of absolute time, as one cannot observe this absolute time. Only the data of clocks, whether they be in a moving or stationary reference frame, are proper for the determination of time."
>
> "Perhaps I have made use of this type of philosophy," answered Einstein, "but it is nonsense, nevertheless. Or, I can say more cautiously, that it may be of heuristic value to recall something which one actually observed. However, from a principled standpoint it is completely false to wish to base a theory only on observable magnitudes. Because, in reality, it is exactly the other way around. The theory first determines what one can observe. . . . I have the suspicion that you will later encounter difficulties in your theory exactly on this point of which we have just spoken. I want to motivate that more exactly. You pretend that you could just leave everything as it is, on the observational side of science, employing the language just as it has been used up to now, to describe what the physicists observe. However, if you do that, you must then also say: In the cloud chamber we observe the path of the electron in the chamber. However in the atom, there is no longer a path for the electron, in your opinion. But this is obviously absurd. Simply by making smaller the space in which the electron moves, the concept of a path cannot be annulled."

When Heisenberg then, obviously confusing mathematics with real Nature, argues that the great power of persuasion of his viewpoint emanates from "the simplicity and beauty of mathematical schema, which is suggested to us by Nature," Einstein nails him on the self-deception which is implied. As Heisenberg reports:

> "The experimental test," Einstein noted, "is certainly the trivial precondition for the correctness of a theory. However, one can never control and recheck everything. So, what you said about simplicity interests me even more. However, I would never claim to really understand what this simplicity of natural law is all about."

One must at least grant the very young and enthusiastic Heisenberg that he made the effort to get an honest understanding, mathematician that he was, in order to be able to grasp this paradox in its totality. Not until his later years was it clear to him that truth wore a different face.

Planck's son Erwin at his Nazi "trial" as a co-conspirator in the attempt to kill Hitler in July 1944. Planck and his longtime friend, Ernst von Harnack, were convicted and executed. This was the culmination of the attempts by the Nazi regime to break Planck's spirit and influence.

Second World War: The End of Science?

In spite of very serious personal misfortunes (within just a few years Planck lost his younger son in the First World War, and both his twin daughters, each after the birth of her first child), he never relinquished his sense of responsibility for others, above all for the next generation, and, therefore, for the future of science. One can assert from the start, that, without him, the great breakthrough in nuclear physics achieved by his students Otto Hahn, Lise Meitner, and Fritz Strassmann would never have succeeded.

At the end of the First World War, the now 60-year-old Planck, positioned at the pinnacle of the Prussian Academy of Science, strove as hard as he could for the reconstruction of the scientific institution. Together with Prussian Minister of Culture Friedrich Schmidt-Ott and academy members Haber and von Harnack, he organized the *Notgemeinschaft der deutschen Wissenschaft* (Emergency Organization of German Science), in which scientists from all regions, professions, and political boundaries could join forces in order to obtain urgent financial means. After his retirement to emeritus status in 1926, Planck continued to work tirelessly through a very active lecture schedule, as editor of the *Annalen der Physik,* and in the founding of the Deutsches Museum in Munich.

But the passage of years only brought more decay to the house of science: The economic crisis caused the income of the Emergency Organization to sink ever lower, while at the same time extremism and anti-Semitism spread within the academic establishment. Positions were filled only with Aryans, even when better qualified Jewish applicants were available. And, as with today's Greenies, Hitler and his followers took an increasingly negative attitude towards science and technology, and held them responsible for both overproduction and mass unemployment. After the takeover by the Nazi Party (NSDAP) in 1933, the situation became dangerous for many scientists, and leading figures like Einstein and Schrödinger had to leave the country. Incendiary flyers against Einstein. were distributed. Owing to the constant attacks against the alleged "Jewish quantum physics" or "Jewish relativity theory," the climate became unbearable, and the scientific landscape was turned into a desert.

Planck, too, was near the point of resigning his positions, and Heisenberg was considering emigration, but then, considering the gloomy prospects for the nation's future, they decided to fight on with the motto *In Deutschland bleiben, weiterarbeiten und retten* (To remain and keep working to save and free Germany). Together with his son Erwin, Planck was a member of the *Mittwochs-Gesellschaft* (Wednesday Club), which was broken up after the July 20, 1944 attempt on Hitler's life. Many members of the *Mittwochs-Gesellschaft* were found guilty of complicity and put to death on February 23, 1945, among them Planck's son Erwin and his childhood friend Ernst von Harnack.

Planck had considered a musical career before deciding upon physics, and music remained important in his life as a realm in which he could freely develop his spirit. He sang in a choir, played the organ and piano like a professional, and studied harmony and counterpoint.

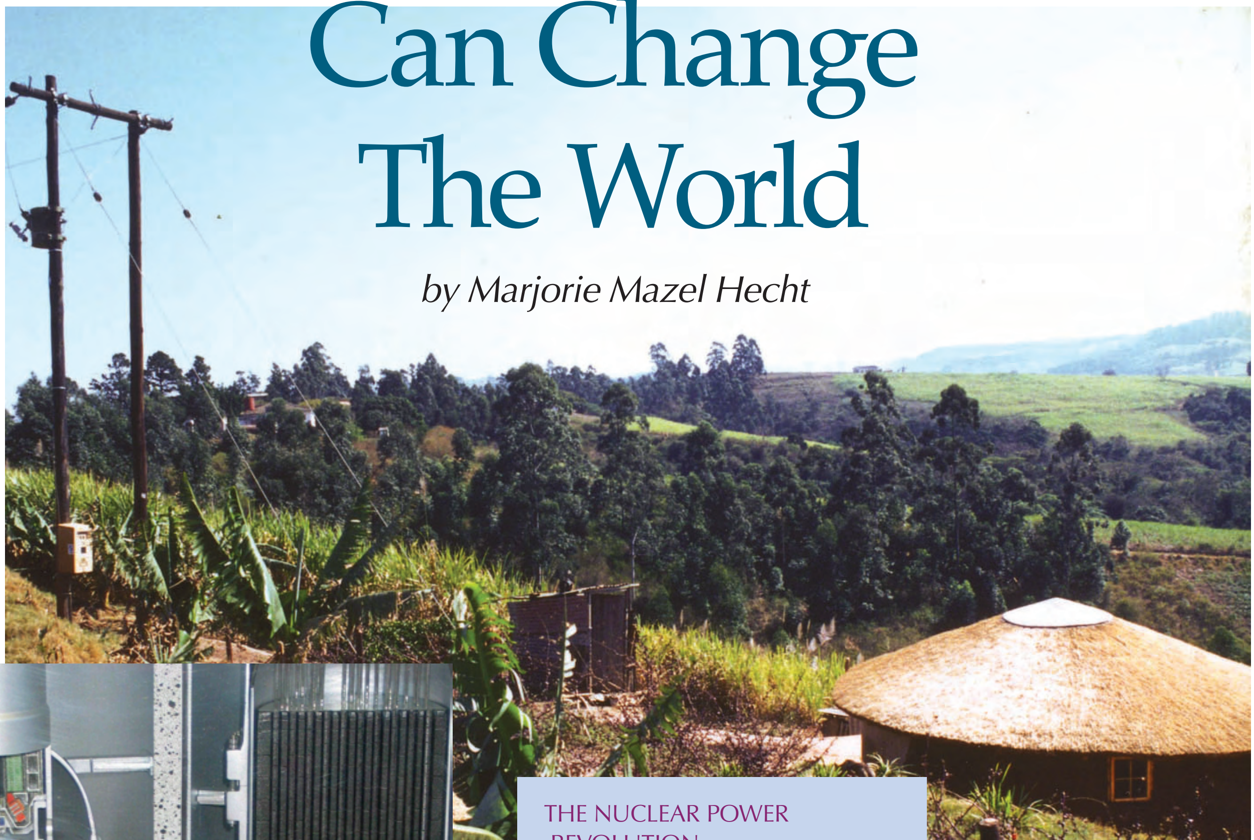
For the 87-year-old Max Planck, the news of the deaths almost killed him, but he doggedly carried on, putting priority on his public lectures, in order "to fulfill the desire of a struggling humanity for truth and knowledge, above all for the youth." His life's motto was a famous saying from his adored Gottfried Wilhelm Leibniz: *"Sieh zu, was du tust; sag an, warum du es tust; denn die Zeit fliesst dahin"* (Watch what you do; say why you do it; for time races by). On Oct. 4, 1947, Planck died at the age of 89, after multiple strokes. His legacy certainly remains very alive, and cries out to scientists: Do not cheat yourself of the truth, if only because theory is so beautifully simple and "the mind is so lazy," as Leibniz put it.

Caroline Hartmann is a longtime organizer with the Lyndon LaRouche movement in Europe. This article first appeared in the German-language newspaper Neue Solidaritaet *(No. 18/2008), and was translated by Laurence Hecht.*

THE NUCLEAR POWER REVOLUTION

Modular High-Temperature Reactors Can Change The World

by Marjorie Mazel Hecht



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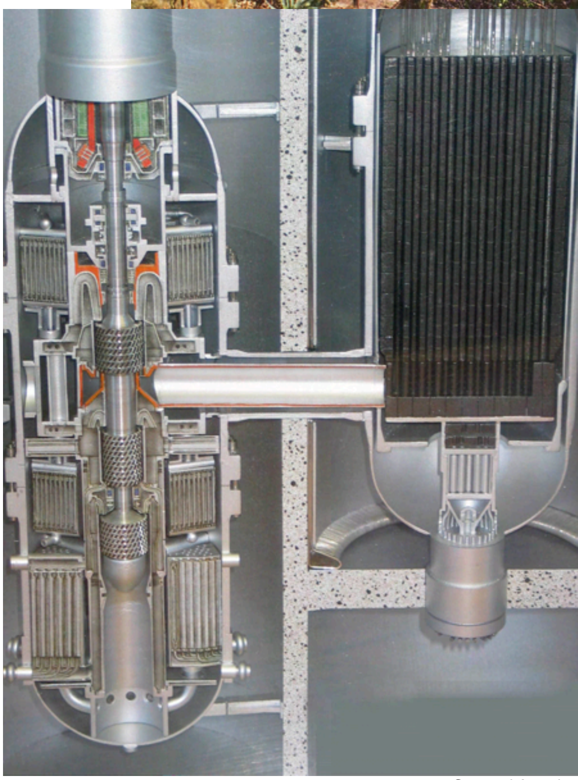


General Atomics

▲ *Electricity transmission line in South Africa.*

Far left: Tabletop model of the Gas-Turbine Modular Helium Reactor (GT-MHR) constructed by the Russian team working with General Atomics on the reactor design. When you push a button, simulated helium flows around the reactor core and power conversion vessel.

Sixty years into the atomic age, we are at the threshold of another revolution: the development of fourth-generation modular high-temperature reactors that are meltdown-proof, affordable, mass-producible, quick to construct, and very suitable for use in industrializing the developing sector. The key to these new reactors, as described here, is in their unique fuel: Each tiny fuel particle has its own "containment building."

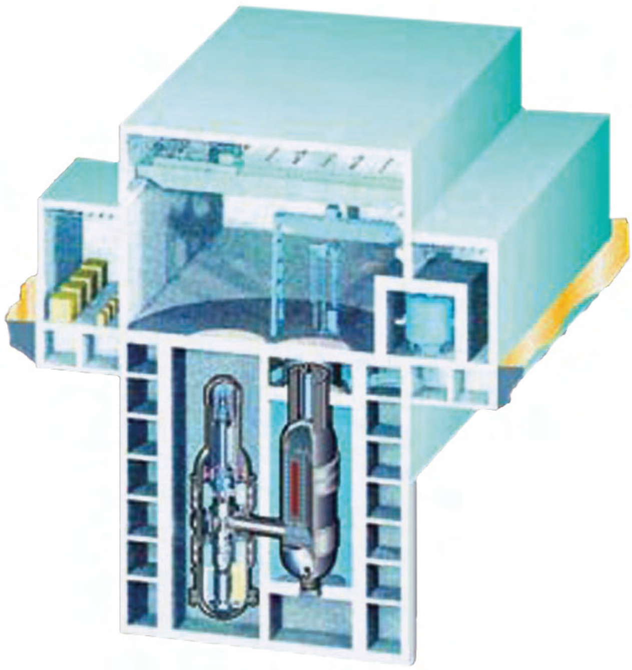
In the days of "Atoms for Peace," the 1950s and early 1960s, it was assumed that the development of nuclear power would rapidly bring all the world's people into the 20th Century, raising living standards, creating prosperity, allowing every individual to make full use of his creative ability. But this dream was not shared by the Malthusian forces, who, even after the massive slaughter of World War II, were determined to cull population further. These oligarchs, like the Olympian Zeus, who punished Prometheus for bringing fire to man, intended to rein in the atom, the 20th Century "fire." And so they did, creating a counterculture, a fear of science and technology, and an environmentalist movement to be Zeus' army to keep Prometheus bound.[1]

Today, we are at a point when nations, especially impoverished nations, can choose to fulfill the promise of Atoms for Peace, by going nuclear, starting with a modular high temperature reactor small enough, ~200 megawatts, to power a small electric grid and, at the same time, provide process heat for industrial use or desalinating seawater. As the economy grows, more modules can be added.

These fourth-generation reactors are fast to construct and affordable (because of their modularity and mass production), thus slicing through the mountain of statistical gibberish promoted by those Malthusians who disguise themselves as energy economists, like Amory Lovins. Now that several leading environmentalists have embraced nuclear as a clean energy solution, the hardcore Malthusians, including prominently Lovins and Lester Brown, have switched their main anti-nuclear argument to claim that nuclear is "too expensive." But because their mathematical calculations do not include the value of human life, Lovins et al. do not consider the human consequences of *not* going nuclear.

Energy Flux Density

If we are to support 6.7 billion people at a living standard worthy of the 21st Century, the world must go nuclear now, and in the future, develop fusion power. Fission is millions of times more energy-flux



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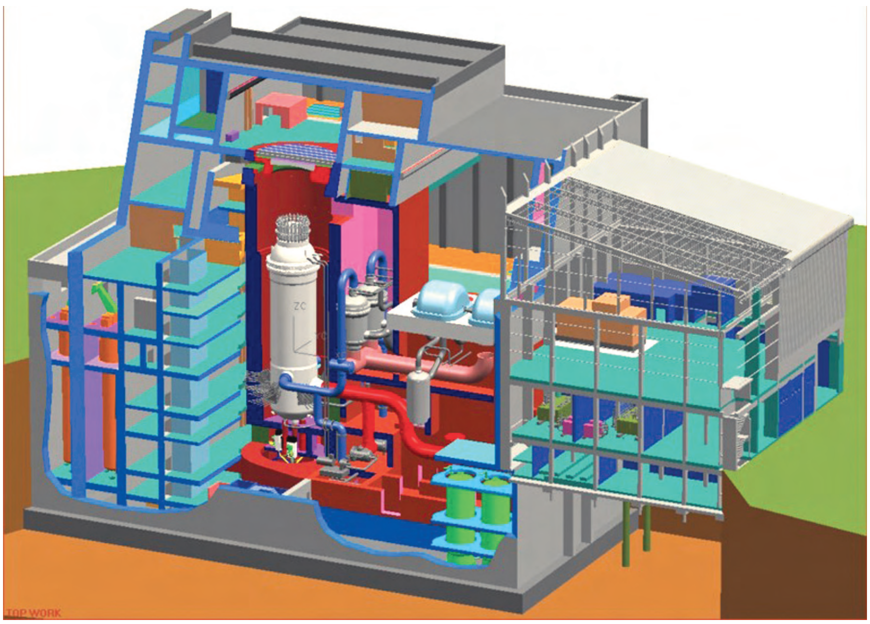
Cutaway view of the prismatic modular reactor showing the reactor vessel (right) and the power conversion vessel (left), both located below ground. This GT-MHR design is for a 285-megawatt-electric reactor.



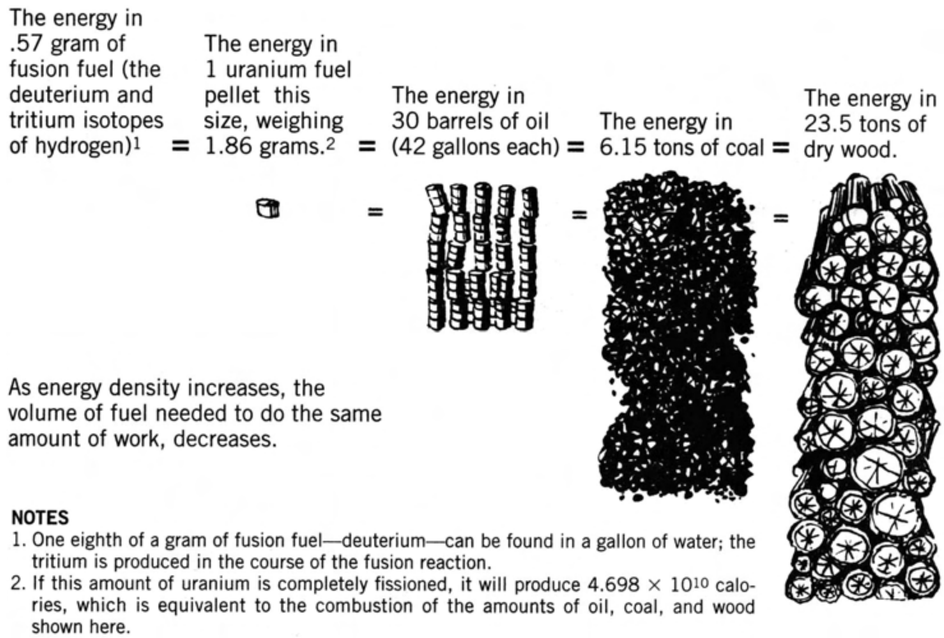
PBMR

A model of the pebble bed modular reactor, showing the reactor vessel at left, with the intercooler and recuperator units to the right. This design is for a 165-megawatt-electric reactor.

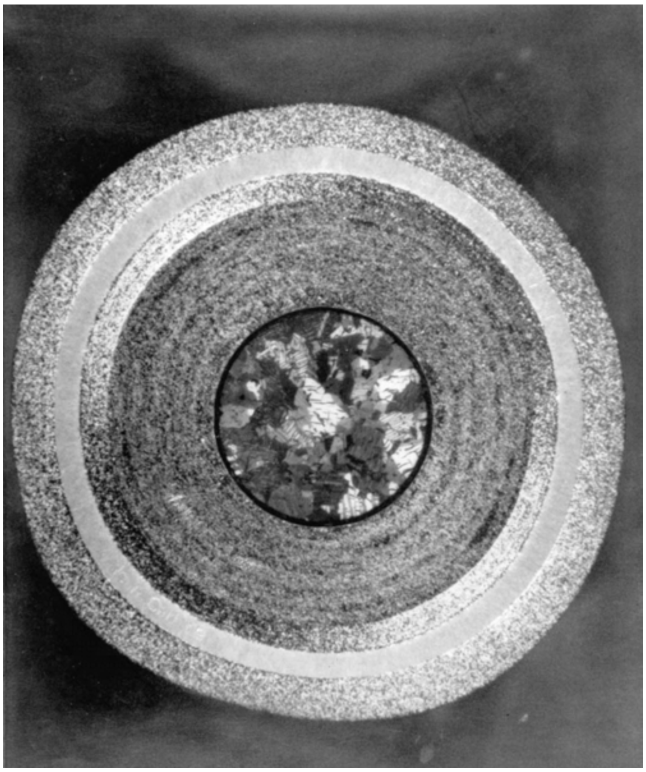
1. See for example, Rob Ainsworth, "The New Environmental Eugenics: Al Gore's Green Genocide," *EIR*, March 30, 2007, www.larouchepub.com/eiw/public/2007/2007_10-19/2007 -13/pdf/36-46_713_ainsworth.pdf; also, Marsha Freeman, "Who Killed U.S. Nuclear Power," *21st Century*, Spring 2001, www.21stcenturysciencetech.com/articles/spring01/nuclear_power.html

Figure 1
FUEL AND ENERGY COMPARISONS

A tiny amount of fission fuel provides millions of times more energy, in quantity and quality, than other sources. With a closed nuclear fuel cycle (which reprocesses used nuclear fuel), and development of the breeder reactor, nuclear is not only a truly renewable resource, but is able to create more new fuel than that used to fuel the reactor.



Source: Calculations made by Dr. Robert J. Moon



General Atomics

Inside a fuel particle: This is a magnified photograph of a .03-inch fuel particle, cut away to show the layers of ceramic materials and graphite surrounding a kernel of uranium oxycarbide fuel. The fission fuel stays intact in its "containment building" up to 2,000°C (3,632°F).

dense than any solar technology, and you can't run a modern industrial economy without this level of energy flux density.

Energy flux density refers to the amount of flow of the energy source, at a cross-section of the surface of the power-producing source. No matter what improvements are made in solar technologies, the basic limitation is that solar power is diffuse, and hence inherently inefficient. At the Earth's surface, the density of solar energy is only .0002 of a megawatt.[2]

Chemical combustion, burning coal or oil, for example, produces energy measured in a few electron volts per chemical reaction. The chemical reaction occurs in the outer shell of the atoms involved, the *electrons*. In fission, the *atomic nucleus* of a heavy element splits apart, releasing millions of electron volts, about 200 million electron volts per reaction, versus the few electron volts from a chemical reaction.

Another way to look at it is to compare the development of power sources over time, and the increasing capability of a society to do physical work: human muscle power, animal muscle power, wood burning, coal burning, oil and gas burning, and today, nuclear. The progress of a civilization has depended on increased energy flux density of power sources. The hand collection of firewood for cooking; tilling, sowing, and reaping by hand; treadle-pumping for irrigation (a favorite of the carbon-offset shysters): These are the so-called "appropriate" technologies that Malthusians advocate for the developing sector, precisely because they preclude an increase in population. In fact,

2. For a discussion of wind as energy, see "Windmills for Suckers: T. Boone Pickens' Genocidal Plan," by Gregory Murphy, *EIR*, Aug. 22, 2008. www.21stcenturysciencetech.com/Articles%202008/Windmills.pdf

these technologies cannot support the existing populations in the Third World—which is exactly why they are glorified by the anti-population lobby.

Although this report will discuss fourth-generation HTRs, to bring every person on Earth into the 21st Century with a good living standard, the nuclear revolution includes the development of all kinds of nuclear plants: large industrial-size plants, fast reactors, breeder reactors, thorium reactors, fission-fusion hybrids, and all sorts of small and even very small reactors. We will also need to fund a serious program to develop fusion reactors. But right now, the modular HTRs are ideal as the workhorses to gear up the global infrastructure building we need.

The Revolutionary Fuel

There are two types of high temperature modular gas-cooled reactors under development, which are distinguished by the way in which the nuclear fuel is configured: the *pebble bed* and the *prismatic* reactor. In the pebble bed, the fuel particles are fashioned into pebbles,

Figure 2
THE UNIQUE HTR FUEL IN A PRISMATIC CONFIGURATION (GT-MHR)

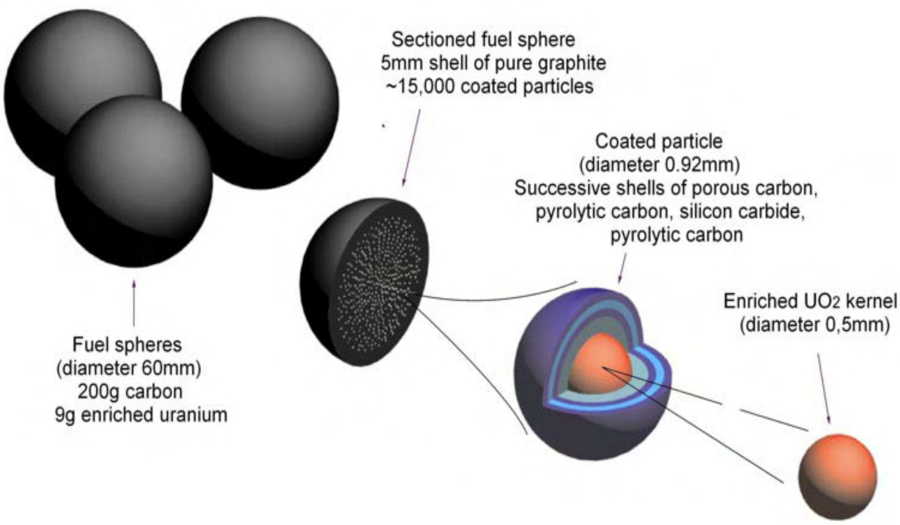
Each tiny fuel particle, three-hundredths of an inch in diameter, has a kernel of fission fuel at the center, surrounded by its "containment" layers. The fuel particles are mixed with graphite and formed into cylindrical fuel rods, about two inches long. The fuel rods are then inserted into holes drilled into the hexagonal graphite fuel element blocks, which measure 14 inches wide by 31 inches high. The fuel blocks, which also have helium coolant channels, are then stacked in the reactor core.

Source: General Atomics

Figure 3
HTR FUEL FORMED INTO PEBBLES (PBMR)

The PBMR fuel particles are similar to those in Figure 2, with a kernel of fission fuel (uranium oxide) at the center (at right). Instead of being fashioned into rods, the particles are coated with containment layers and then inserted into a graphite sphere to form "pebbles" the size of tennis balls (at left). Each pebble contains about 15,000 fuel particles. Pebbles travel around the reactor core about 10 times in their lifetime. During normal operation, the reactor will be loaded with 450,000 fuel pebbles.

Source: PBMR



fuel balls the size of tennis balls, which circulate in the reactor core. In the prismatic reactor, the fuel particles are fashioned into cylindrical fuel rods, that are stacked into a hexagonal fuel block.

South Africa is developing the Pebble Bed Modular Reactor, the PBMR, and China has an operating 10-megawatt HTR of the pebble bed design, with plans to construct a commercial 200-megawatt unit starting in 2009.

General Atomics, based in San Diego, is developing the Gas Turbine Modular Helium Reactor, GT-MHR, which has a prismatic fuel rod design, and Japan is operating a 30-megawatt high temperature test reactor, HTTR, of the prismatic design.

Although the fuel configurations differ, both reactor types start with the same kind of fuel particles, and it is these tiny fuel particles that will revolutionize electricity generation and industry throughout the world. Developed and improved over the past 50 years, these ceramic-coated nuclear fuel particles, three-hundredths of an inch in diameter (0.75 millimeters), make possible a high-temperature reactor that cannot melt down.

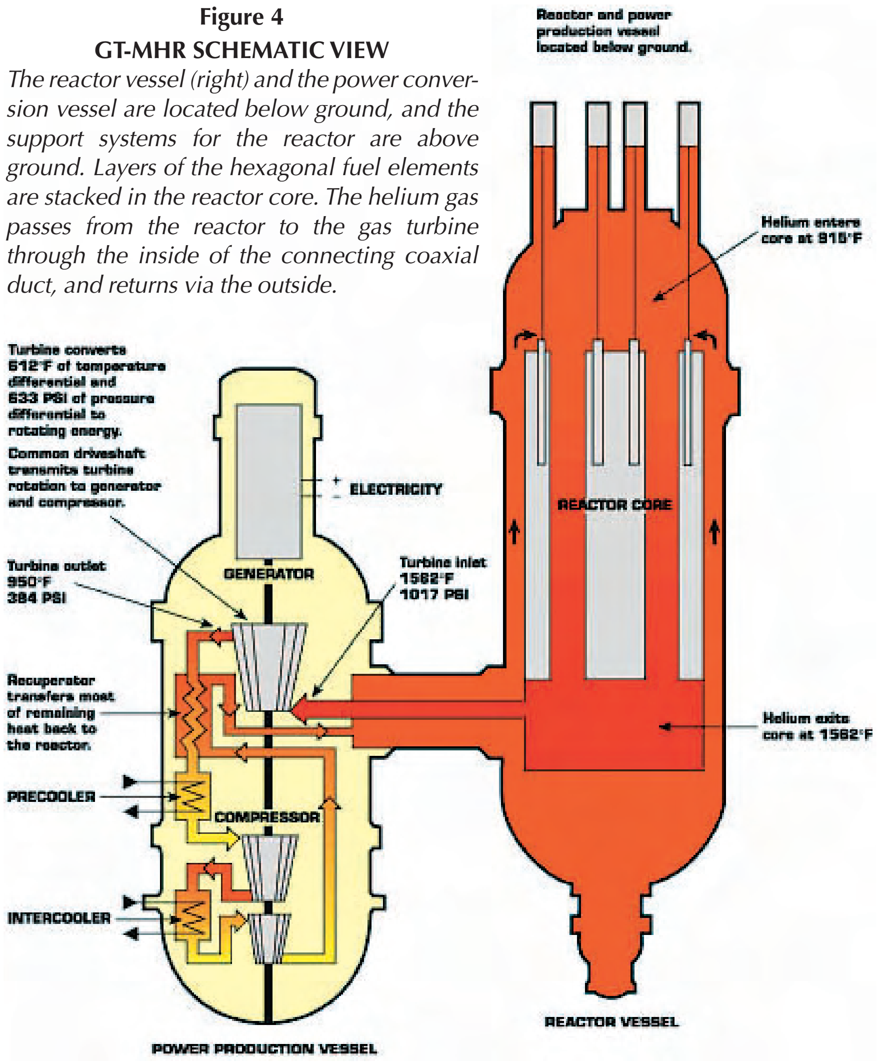


Figure 4
GT-MHR SCHEMATIC VIEW
The reactor vessel (right) and the power conversion vessel are located below ground, and the support systems for the reactor are above ground. Layers of the hexagonal fuel elements are stacked in the reactor core. The helium gas passes from the reactor to the gas turbine through the inside of the connecting coaxial duct, and returns via the outside.

At the center of each fuel particle is a kernel of fissile fuel, such as uranium oxycarbide. This is coated with a graphite buffer, and then surrounded by three or more successive containment layers, two layers of pyrolytic carbon and one layer of silicon carbide. The nuclear reaction at the center is contained inside the particle, along with any products of the fission reaction. The ceramic layers that encapsulate the fuel will stay intact up to 2,000°C (3,632°F), which is well above the highest possible temperature of the reactor core, 1,600°C (2,912°F), even if there is a failure of the coolant.

The Chinese tested this in the HTR-10 in September 2004, turning off the helium coolant. The reactor shut down automatically, the fuel temperature remained under 1,600°C, and there was no failure of the fuel containment. This demonstrates both the inherent safety of the reactor design, and the integrity of the fuel particles, stated Frank Wu, CEO of Chinery, the consortium appointed by the Chinese government to head the development project.

As for the waste question: The HTRs produce just a tiny amount of spent fuel, the less to store or bury. But the rational question is, why bury it and throw away a resource? Why not reprocess it into new nuclear fuel?

General Atomics had an active research program investigating the reprocessing of spent fuel from the HTR, but when the United States gave up reprocessing in the 1970s under the banner of "nonproliferation," the facility was converted to do other research. As one longtime General Atomics nuclear engineer told me, reprocessing used HTR fuel is absolutely possible—you just have to want to figure out how to do it.

Fission in the HTR

Conventional fission reactors work much like their predecessor technologies. The fission reaction produces heat, the heat boils water to create steam, and the steam turns a turbine, which is attached to a generator to produce electricity.

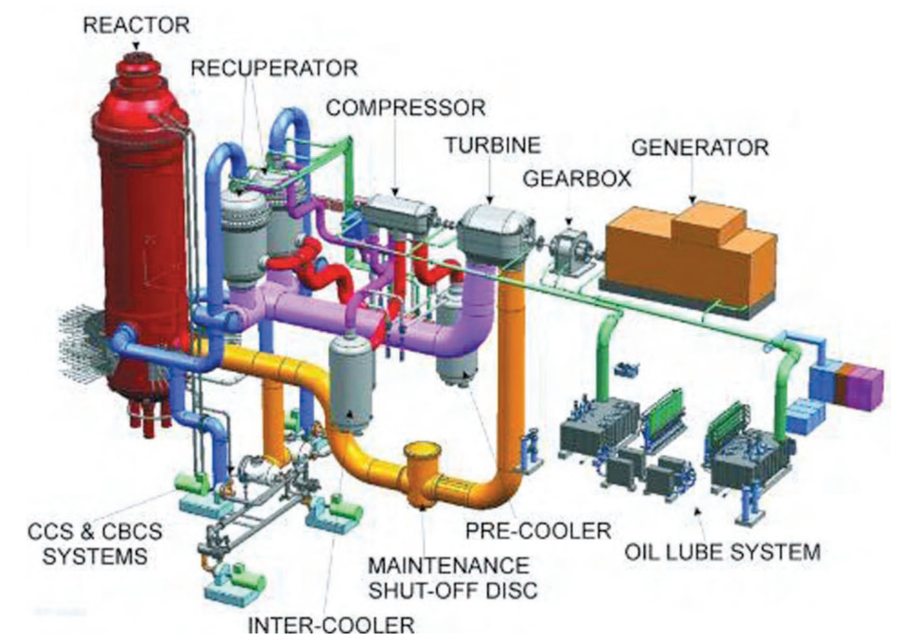


Figure 5
PBMR REACTOR CONFIGURATION
The reactor vessel (left) and the systems for power conversion in the PBMR. The PBMR fuel is in the form of tennis-ball size pebbles, which circulate in the reactor vessel. Helium gas conveys the reactor heat to the gas turbine and generator; the helium is then cooled, recompressed, and reheated before returning to the reactor vessel.
Source: PBMR

The fourth-generation reactors also use the fission reaction to produce heat, but instead of boiling water, the heat is used to heat helium, an inert gas, which then *directly* turns a turbine, which is connected to a generator to produce electricity. By eliminating the steam cycle, these HTRs increase the reactor efficiency *by 50 percent,* thus reducing the cost of power production.

An obvious question is: How does the fission chain reaction occur if all the fission products are contained inside the fuel particles? The key is the neutron.

When the atomic nucleus of uranium splits apart, it produces heat in the form of fast-moving neutral particles (neutrons) and two or more lighter elements. To sustain a controlled fission chain reaction, every nucleus that fissions has to produce at least one neutron that will be captured by another uranium nucleus, causing it to split. The fission process is very fast; ejected neutrons stay free for about 1/10,000 of a second. Then they are either captured by fissionable uranium, or they escape without causing fissioning, to be captured by other elements or by nonfissionable uranium. Free neutrons can travel only about 3 feet.

All nuclear reactors are configured to create the optimum geometry for neutron capture by fissionable uranium. The point of a controlled fission reaction is to engineer the reactor design to capture the right proportion of slow neutrons in order to produce a steady fission reaction. (It is the slower neutrons that cause fissioning; the fast neutrons tend to be captured without causing fissioning.) For this purpose, reactors have *control rods,* made of materials like neutron-absorbing boron, that are raised or lowered to absorb neutrons, and *moderators,* made of a lighter element like carbon (graphite), that slow the neutrons down.[3]

In conventional nuclear reactors, water is the usual moderator, and the fission products stay inside the reactor core's fuel assembly. In the HTR, each tiny fuel particle contains the fission products produced by its uranium fuel kernel; only the neutrons leave the fuel particles.

Helium Gas: Heats and Cools

The beauty of the high temperature reactor, and the reason that it can attain such a high temperature (1,562° F, or 850°C compared with the 600°F of conventional nuclear plants) lies in the choice of helium, the inert gas that carries the heat produced by the reactor. Helium has three key advantages:

• Helium remains as a gas, and thus the hot helium can directly turn a gas turbine, enabling conversion to electricity without a steam cycle.

• Helium can be heated to a higher temperature than water, so that the outlet temperature of the HTR can be higher than in conventional water-cooled nuclear reactors.

• Helium is inert and does not react chemically with the fuel or the reactor components, so there is no corrosion problem.

The helium circulates through the nuclear core, conveying the heat from the reactor through a connecting duct to the turbine. Then it passes through a compressor system, where it is cooled to 915°F (490°C), and re-enters the nuclear core. The use of helium as both the coolant and the gas that turns the turbine simplifies the reactor by eliminating much of the equipment (and expense) of conventional reactors.

The high heat that is produced can be coupled with many industrial processes, such as desalination of seawater, hydrogen production, coal liquefaction, and so on. These reactors are also small enough to be located on site for some industries, producing both electricity and process heat. The LaRouche plan for the Eurasian Land-Bridge and the World Land-Bridge,

3. For more detail, see "Inside the Fourth-Generation Reactors," *21st Century,* Spring 2001.

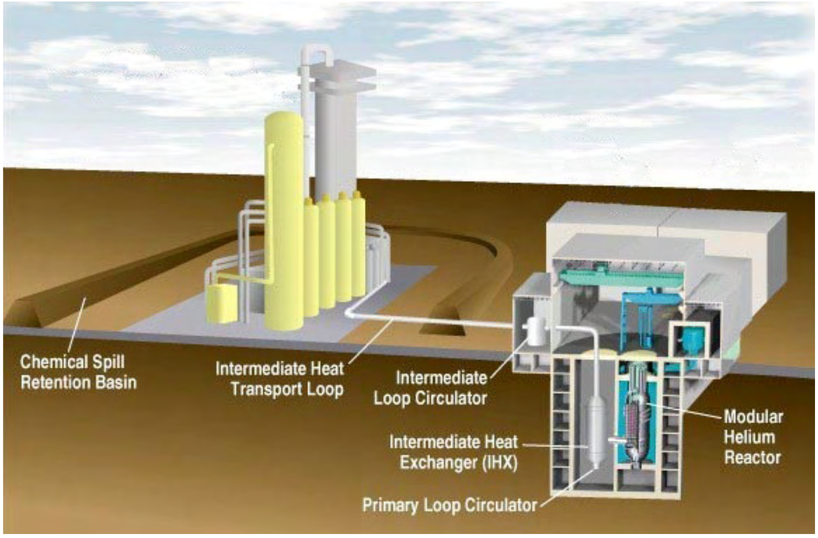


Figure 6
GT-MHR COUPLED WITH HYDROGEN PRODUCTION PLANT
This General Atomics design couples the GT-MHR, to a sulfur-iodine cycle hydrogen production plant. The sulfur-iodine cycle, which uses coupled chemical reactions and the heat from the high-temperature reactor, is the most promising thermochemical method for hydrogen production.
Source: General Atomics

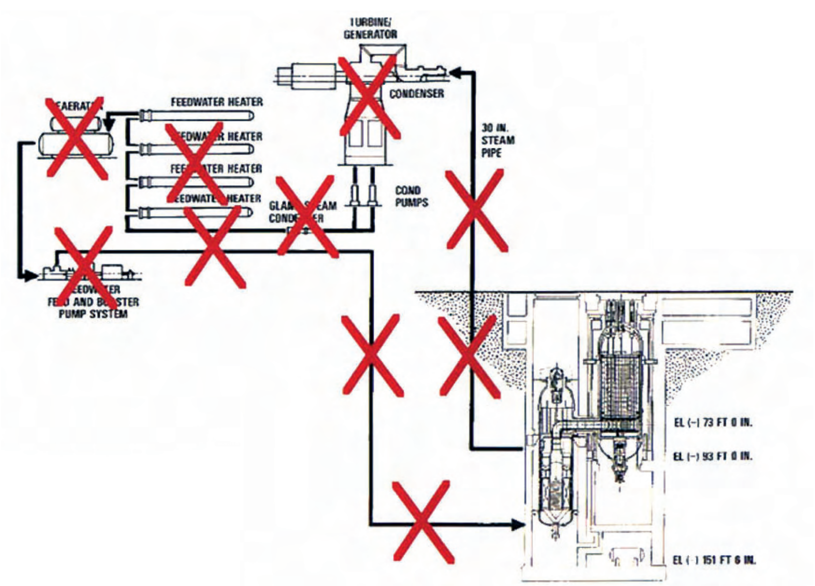


Figure 7
SIMPLICITY OF DIRECT-CONVERSION POWER GENERATION
Using direct conversion with a gas turbine eliminates the steam cycle from the HTR, as shown here. At the same time, direct conversion increases the efficiency of the reactor by 50 percent.
Source: General Atomics

for example, envisions these HTR reactors as the hub of new industrial cities across Eurasia and the harsh Arctic environment of eastern Russia, linked by high-speed and magnetically levitated railways.

Direct Conversion to Electricity

The HTRs, as noted above, gain efficiency by eliminating the steam cycle of conventional nuclear reactors (the heating of water to turn it into steam, which then turns a turbine). Instead, the helium gas carries the heat of the nuclear reaction to *directly* turn a gas turbine.

Like conventional nuclear reactors, the first high temperature reactors—Peach Bottom in Pennsylvania and Fort St. Vrain in Colorado, for example—used a steam cycle. The Chinese HTR-10 also uses a steam cycle, but plans are to switch to a direct conversion system in its later models.

It only became possible to use the Brayton direct-cycle gas turbine with the HTRs after advances in industrial gas turbine use, and work carried out at the Massachusetts Institute of Technology during the 1980s specifically for coupling HTRs with a Brayton cycle. There were also advances in related systems, such as the recuperators and magnetic bearings. Taken together, these advances give the HTRs an overall efficiency of about 48 percent, which is 50 percent more than the efficiency of conventional nuclear reactors.

Multiple Safety Systems: Meltdown Proof

The modular HTRs are inherently safe, because they are designed to shut down on their own, without any human operator's intervention. Even in the unlikely event that all the cooling systems fail, the reactor would shut down safely, dissipating the heat from the core without any release of radioactivity.

The built-in safety systems, as discussed above, include the unique fuel particle containment: the fission products stay inside these "containment" walls.

Another safety feature is the reactor's

"negative temperature coefficient" operating principle: If the operating temperature of the reactor goes up above normal, the neutron speed goes up, which means that more neutrons get captured without fissioning. In effect, this shuts down the chain reaction. Additionally, there are certain amounts of "poisons" present in the reactor core (the element erbium, for example), which will help the process of capturing neutrons without fissioning, if the operating temperature goes up.

The first line of safety in regulating the fission reactor is, of course, the control rods, which are used to slow down or speed up the fissioning process. But if the control rods were to fail, the reactor is designed automatically to drop spheres of boron into the core; boron absorbs neutrons without fissioning, and thus would stop the reaction.

Additionally, there are two external cooling systems, a primary coolant system and a shutdown coolant system. If both of these should fail, there are cooling panels on the inside of the reactor walls, which use natural convection to remove the core heat to the ground. Because the reactor is located below ground, the natural conduction of heat will ensure that the reactor core temperature stays below 1,600°C, well below the temperature at which the fuel particles will break apart.

Prof. Rudolf Schulten (center), who developed the pebble bed design and built the first pebble bed reactor, was made a guest professor of Tsinghua University, where China's HTR-10 was built on the pebble bed model.

The graphite moderator also helps dissipate heat in a shutdown.

In addition to the successful Chinese HTR-10 test shutdown, a similar test was carried out on the AVR, the German prototype for the pebble bed, at Jülich. In one test, reactor staff shut down the cooling systems while the reactor was operating. The AVR shut itself down in just a few minutes, with no damage to the nuclear fuel. In other words, no meltdown was possible.

The HTR: A Manhattan Project Idea

The idea of a high-temperature gas-cooled reactor dates back to the Manhattan Project and chemist Farrington Daniels, who designed a nuclear reactor, then called a "pile," which had "pebbles" of fission fuel whose heat was removed by a gas. Daniels patented his idea in 1945, calling it a "pebble bed reactor," and the Oak Ridge National Laboratory began to work on the concept. But Daniels's idea was dropped, in favor of the pressurized water reactor, and the group working with Daniels went on to design the first nuclear reactor for the *Nautilus* submarine.[4]

Later, Great Britain, Germany, and the United States developed high-temperature gas-cooled reactors. In Germany, Prof. Rudolf Schulten began working on a pebble-bed type reactor,

Petr Pavlicek/IAEA

EIRNS

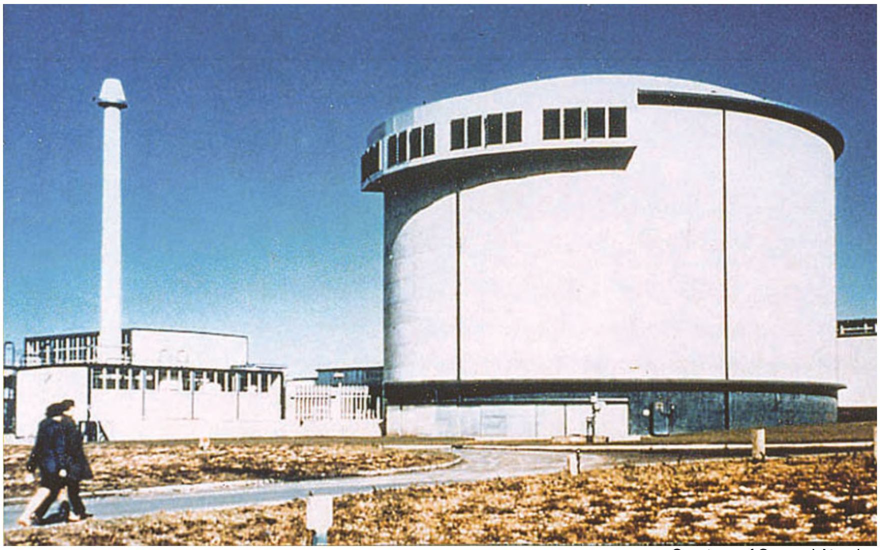
Chinese technicians in the control room of the experimental HTR-10. China plans to construct a commercial-size 200-megawatt HTR starting in 2009.

Inset: Mary Burdman of EIR *holding a Chinese fuel pebble on a visit to the HTR-10 in 2001.*

4. Manhattan Project veteran Alvin M. Weinberg, who headed Oak Ridge National Laboratory, describes this in his autobiography, *The First Nuclear Era: The Life and Times of a Technological Fixer* (Woodbury, N.Y.: American Institute of Physics Press, 1994).

and designed the 40-megawatt AVR pebble-bed reactor at Jülich, which operated successfully from 1966 to 1988, producing power for the grid and yielding a wealth of research data. Both this and a subsequent larger HTR were shut down in 1988, as the anti-nuclear movement rode the wave of Chernobyl fear. South Africa's PBMR, as well as the Chinese HTR-10, makes use of the Schulten pebble-bed system, with innovations particular to each of the two new designs.

In Europe, 13 countries collaborated on the experimental high temperature gas reactor called Dragon, built in England in 1962. The 20-megawatt Dragon operated successfully from 1964 to 1975, testing materials and fuels, and its experimental results were used by later HTR projects, including the THTR and the Fort St. Vrain HTR.



Courtesy of General Atomics

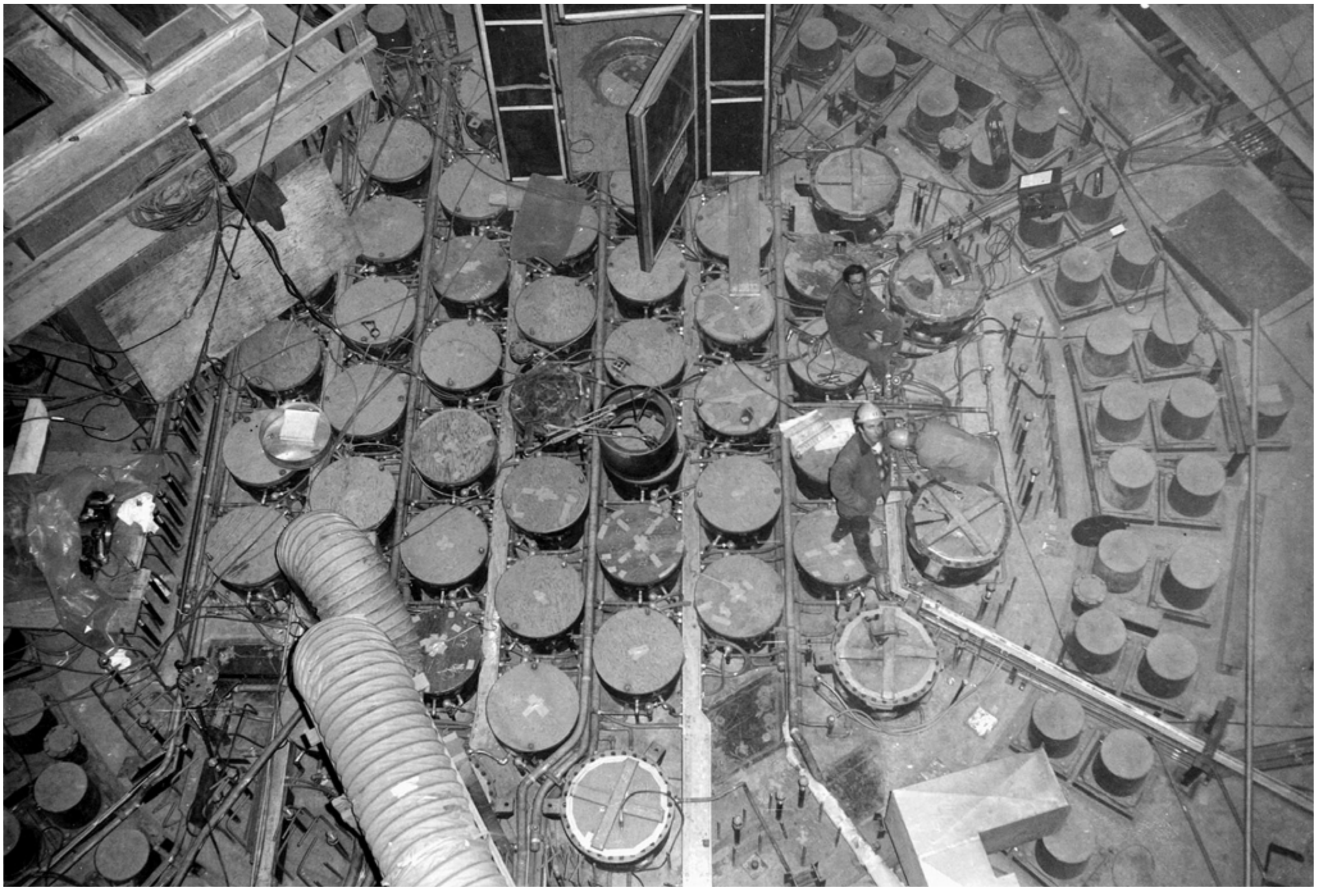
The 20-megawatt Dragon high-temperature nuclear reactor in England, operated from 1964 to 1975 as an experimental project of several European countries.

In the United States, Peach Bottom 1 in Pennsylvania was the first commercial HTR, put into planning in 1958, just a year after the first U.S. nuclear plant went on line at Shippingport, Pennsylvania. Built by General Atomics and operated by the Philadelphia Electric Company, the prototype HTR operated successfully from 1966 to 1974, producing power for the grid and operating information on HTRs. As General Atomics' Linden Blue characterized it, Peach Bottom worked "like a Swiss watch." Unit 1 at Peach Bottom was followed by two conventional boiling water reactors at the same site.

General Atomics next built a larger HTR, the 330-megawatt Fort St. Vrain plant in Colorado, which operated from 1977 until 1989, using a uranium-thorium fuel. Unfortunately mechanical problems with the bearings—a non-nuclear problem—made the plant too expensive to operate, and it was shut down. (Gen-

Courtesy of Exelon Nuclear

The Peach Bottom nuclear power plant in Pennsylvania, the first U.S. commercial high-temperature reactor, operated "like a Swiss watch." Unit 1 is the white-domed structure, at left. Two conventional boiling water nuclear reactors are operating now at the site.



General Atomics

Inside the reactor core of Fort St. Vrain high-temperature reactor in Colorado, during construction. The 330-megawatt plant had mechanical problems with the bearings, which made it uneconomical to operate, and it was shut down in 1989.

eral Atomics' Linden Blue discusses this in the accompanying interview.) Later, Fort St. Vrain was transformed into a natural gas power plant.

General Atomics continued its HTR research through the 1980s and in 1993, began a joint project with the Russians to develop the GT-MHR, with a focus on using the reactor to dispose of surplus Russian weapons-grade plutonium, by burning it as fuel. The HTR is particularly suitable for this purpose, because of the high burnup of fuel (65 percent). Later in the 1990s, the French company Framatome and Japan's Fuji Electric joined the program.

Today the conceptual design for the GT-MHR is complete and work continues to advance on the engineering, but construction cannot start until sufficient funds are available. The site selected for the reactor is Tomsk-7, a formerly "secret city" for production of plutonium and weapons, today known as Seversk.

In 2006, the University of Texas at the Permian Basin selected the GT-MHR design as the focus for a new nuclear research reactor, to be built in West Texas near Odessa.[5] General Atomics, Thorium Power, and the local communities contributed funds for the initial conceptual design. Now the University has just signed a Cooperative Research and Development Agreeman with Los Alamos National Laboratory, to develop a "pipeline of new nuclear reactor engineers" (a Bachelors degree program) to be ready immediately for working in power plants, national laboratories, or one of the U.S. nuclear agencies. According to the agreement, Los Alamos will send its scientists and engineers to the campus to teach and lead research, along with R&D equipment. The University's engineering staff will work with Los Alamos on research and joint seminars.

The project is named HT^{3}R (pronounced "heater"), which stands for high-temperature teaching and test reactor. Dr. James Wright, who manages HT^{3}R, told this writer that the initial efforts will be "geared toward developing any non-nuclear simulation or calculation that will move the HTGR technology forward to commercial deployment." Wright said that they would like to "eventually find a way to participate in an advanced reactor test facility like the HT^{3}R, but we are not necessarily tied to any particular design. Again, our goal is to move the HTGR technology to commercial deployment as fast as possible." In Wright's personal view, such a first reactor could be built without Federal involvement or money, "if the economics are right."

5. See an interview with James Wright, "Texas University to Build HTR Reactor," www.21stcenturysciencetech.com/2006_articles/spring%202006/Nuclear_Report.pdf

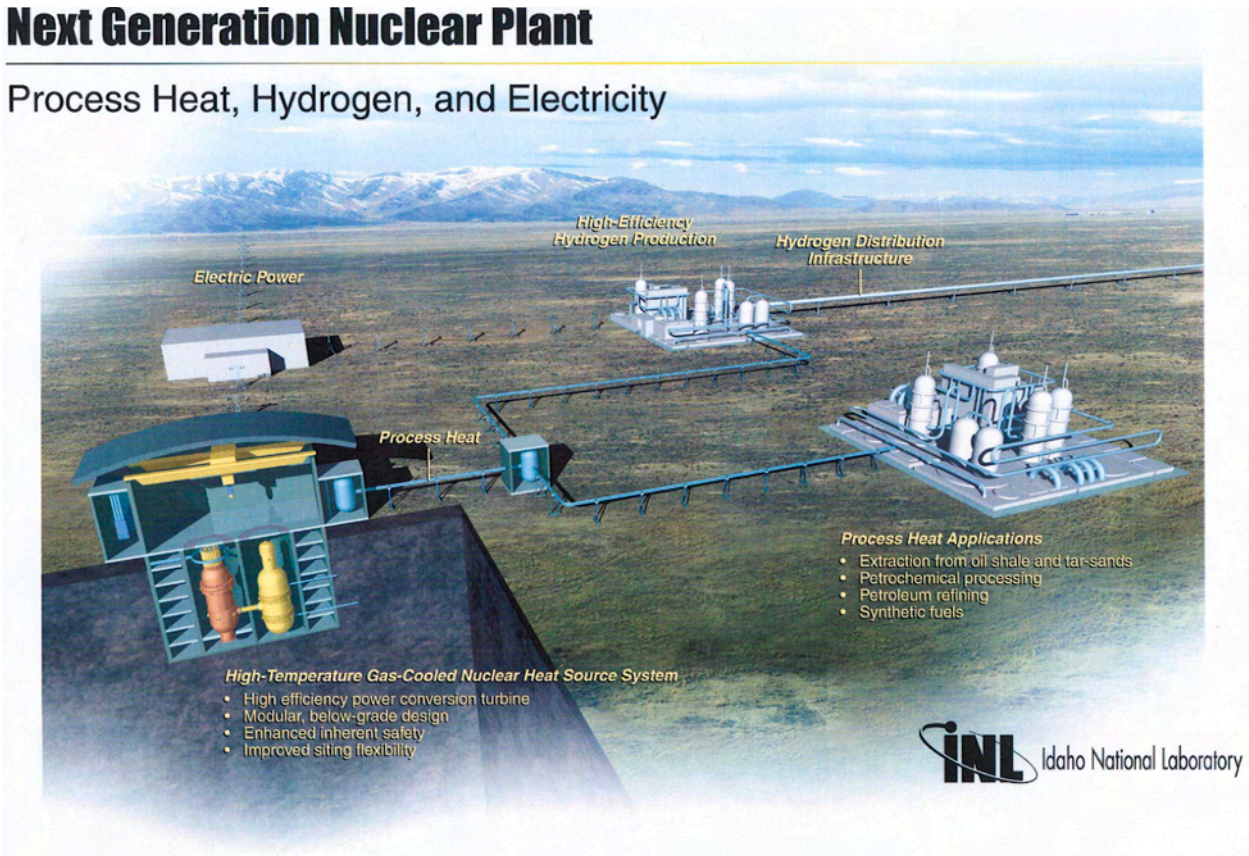


Figure 8

The Idaho National Laboratory's conception of the Next Generation Nuclear Plant, a high-temperature gas-cooled reactor which would be used to produce electricity and high-quality heat for the production of synthetic fuels like hydrogen, and for process heat applications in industry. The U.S. Next Generation Nuclear Plant program, based at the Idaho National Laboratory has not yet selected an HTR design (pebble bed or prismatic), and is on a very slow trajectory, aiming for a commercial plant in 2030. Meanwhile, China and Japan have working experimental HTRs, and South Africa plans to move to construction with the PBMR next year.

Will the U.S. Catch Up?

The Department of Energy's Next Generation Nuclear Plant program plans to put a commercial-size HTR on line . . . by the year 2030. So far, two industry groups have received a small amount of funding for design studies, and there is a target date of 2021 for a demonstration reactor of a type (pebble bed or prismatic) to be determined. But even that slow timetable is not sure, given the budget limits and lack of political priority.[6] This HTR project, called the Very High Temperature Reactor, is based at Idaho National Laboratory, and is planned for coupling with a hydrogen production plant. At the slow rate it is going, the United States, a former nuclear pioneer, may find itself importing this next-generation technology from a faster advancing nation.

The other problem is that the Next Gen program has taken a backseat to the Bush Administration's Nuclear Energy Partnership (GNEP) program. The political thrust of the Department of Energy's GNEP is to prevent other nations (especially those unfavored nations) from developing the full nuclear fuel cycle, by controlling the enrichment and supply of nuclear fuel. In line with nonproliferation, GNEP's focus is on building a fast (breeder) reactor that is "proliferation proof"—one that would burn up plutonium, preventing any diversion for bomb making. Nonproliferation, an obsession with both the Bush Administration and the Democrats, in reality is just a euphemism used for years by the Malthusian anti-nuclear movement to kill *civilian* nuclear power.[7]

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6. This program is discussed in "It's Time for Next Generation Nuclear Plants" by Marsha Freeman, *21st Century,* Fall 2007, www.21stcenturysciencetech.com/Articles%202007/NextGen.pdf

7. For more on this topic, see "The Neo-cons Not Carter Killed Nuclear Energy," *21st Century,* Spring-Summer 2006, www.21stcenturysciencetech.com/2006_articles/ spring%202006/Wohlstetter.pdf; and "Bush Nuclear Program: Technological Apartheid," *EIR,* July 6, 2007.

INET

Will the U.S. be left behind? PBMR and China both plan to start HTR construction in 2009. Above: Artist's depiction of planned site for a commercial HTR in China.

Below: Artist's illustration of the planned PBMR facility at Koeberg, South Africa, near the location of two conventional nuclear reactors.

PBMR

It would make sense under the Next Gen program for the United States to build a prototype GT-MHR, because the South Africans are building a PBMR, and this would give the world working models of each type. But at the present pace and budget, without a major commitment on the level of the Manhattan Project, a U.S. demonstation reactor is barely on the horizon.

The problem is not with the technology. Speaking at a press conference on the HTR in Washington, D.C. on Oct. 1, Dr. Regis Matzie, Senior Vice President & Chief Technology Officer at Westinhouse, who chaired the HTR 2008 conference, stated flatly, "We don't have a national priority" on building an HTR, and other countries which do—South Africa and China, for example—can move faster. At the same press conference, Linden Blue summed up the current HTR situation philosophically. With any new technology he said, you have an initial period of ridicule; then the technology is viciously attacked; and then, finally, the technology is adopted as self-evident. Soon after that, Blue said, everyone will be commenting on that first HTR, "What took you so long?"

The nuclear power revolution is now within our grasp, here in the United States, in South Africa, in China, in Japan, in Europe. The cost of developing the HTR is minuscule, in comparison with the trillions of dollars being sunk into the unproductive and losing gamblers on Wall Street. The cost of *not* developing these fourth-generation reactors will be measured in lives lost, and perhaps civilizations lost.

The Modular High-Temperature Reactor: Its Time Has Come!

Marjorie Hecht

Linden Blue is vice chairman of General Atomics in San Diego, where he is responsible for the development of the advanced gas-turbine modular helium reactor (GT-MHR). General Atomics, which has a wide range of high-technology projects, has been involved with the development of HTRs for more than 50 years. Mr. Blue was formerly CEO of Beech Aircraft and general manager of Lear Jet, both in Wichita, Kansas. He was interviewed by Marjorie Mazel Hecht on Oct. 27, 2008.

"Technology is a wonderful thing! People invent better things to solve problems. And this is exactly what's happened here. Over this 50-year period, the reactor design has improved dramatically. We've made mistakes, and we've cured them. And now we have something that is so safe, and so economical, and so efficient, and so non-polluting, that its time has come."

Question: Your outlook has always been visionary: You see the need worldwide for a reliable, safe power source. What do you think will enable us to turn the corner, and begin mass production?

Historically we've gotten our economics in nuclear by making the plants bigger and bigger, and getting "the economies of size scale." But the reality is that everything we have in life that is, let's say, economical, has gotten that way because it's *mass produced.* Everything from coffee cups to cars. There are no exceptions that I can think of right now.

Well, obviously, we're not going to produce nuclear reactors in the numbers that we've produced cars, but perhaps a better analogy would be airplanes, which are produced in serial production, in relatively low numbers. The learning curve get the costs down through serial production. I think it's possible that if you get the right sized gas reactor, you can have these produced in quantities where you get all the benefits of mass production, with favorable learning curves.

Said another way, there are two ways to get economy: One is to make the reactors bigger and bigger, which seems to have reached the point of diminishing return, and the other way is through mass-production.

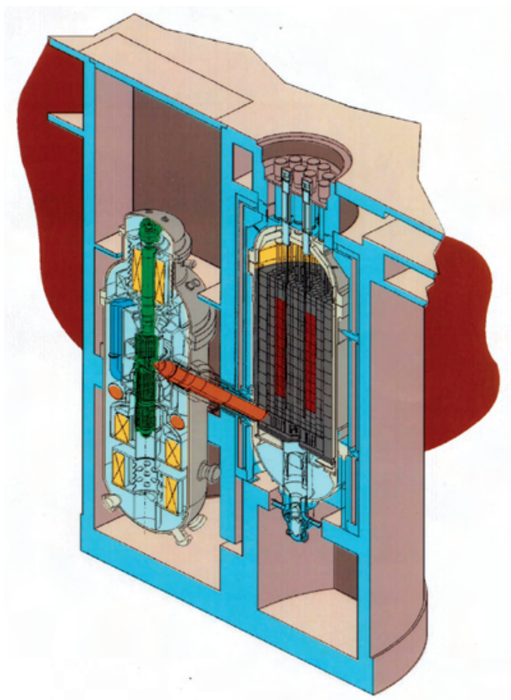
The latest projection for light water reactors, because of the run-up of commodity prices, has been as high as $6,000 per kilowatt, and if you have a 1,200-megawatt reactor, you're looking at $7 or $8 billion. That's a huge amount, to say nothing of the sometimes disruptive effect of dropping 1,000 or 1,200 megawatts into a given market.

Question: You're talking about the capital cost here.

Yes, that's the capital costs, construction. The operating economics are affected by the 50 percent greater efficiency of the gas reactor. Overall, you have an equation that's pretty hard to beat.

Question: And the GT-MHR is designed at a size to be mass produced?

Yes, a good size would range from 100 to 300 megawatts for the HTR, versus 1,200 megawatts for a conventional water reac-



General Atomics

Cutaway view of the GT-MHR, showing the reactor vessel (right) and power conversion vessel. The helium gas directly drives a gas turbine generator, which gives the reactor nearly a 50 percent increase in efficiency.

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Serial production, as with these airplanes during World War II, will enable the fourth-generation nuclear reactors to be economical. Here, an airplane assembly line at the Canadian Car and Foundry Co., in Fort William.

tor. You're duplicating the learning in the production process six times as frequently, and that makes a huge difference. So, the modular approach has always been attractive. Now it's mostly a matter of doing it.

The history of how the light water reactors came about—they came out of submarines. They were the only ones that were available at the time. They've served us well, but the question is, is that what we want to build a lot of for the future? My answer would be no: You want to build the safest possible reactor that you can, and the most economical. I believe that takes you to the modular approach for economy and the inherent safety approach for safety. To do that, you need ceramic fuel and a Brayton cycle. Helium as the heat transfer fluid enables both.

When you are dealing with higher temperatures of a gas reactor and a Brayton cycle instead of a Rankine cycle, you get on the order of 50 percent more thermal efficiency. That is *huge* in something as basic as primary energy. You create heat and turn it into some kind of work. Steam cycles have been doing that very well, ever since Robert Fulton and the steamboat, but there's a better way, if you can use a fluid like helium to directly drive a turbine. So, to go from 33 percent efficiency to 48 percent—nearly a 50 percent increase in efficiency—that's tremendously significant. That lays the foundation for considerably greater economics.

Question: How are we going to gear up to get this done? What manufacturing resources exist already, and what would we need to create?

I think we really have all the resources to do it. Let's just walk through that.

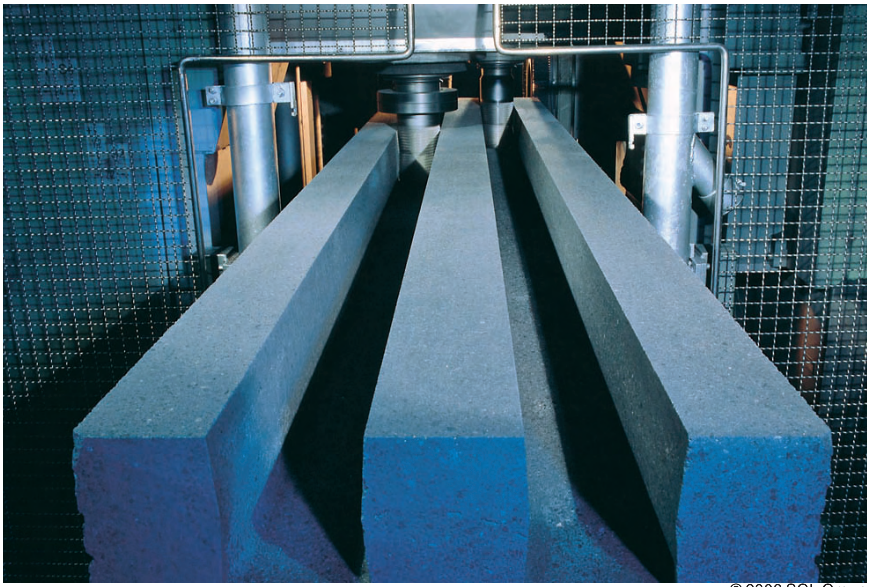
First of all, you've got to have *reactor vessels.* Well, that takes heavy steel. There's heavy steel capability here in the U.S. The steel needs to be rolled, and then some of the fittings need to be machined. There's plenty of machining capability here for that purpose.

Some of the big light water reactors require forgings, and these can only be made in Japan. But I think if we make ours the right size, we'll be able to produce them in a variety of places around the world, rather than using the tremendously expensive forgings.

Question: Right now in Japan, I think if they gear up they can only do nine a year, so that's not exactly mass production.

United Steelworkers

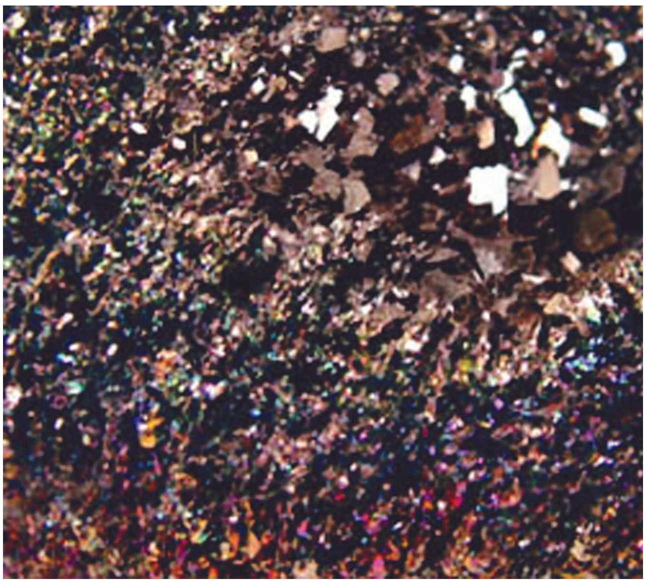
Inside a steel rolling mill, where slabs of steel are transformed into plates, sheets, and strips. Reactor vessels for the modular HTR can make use of heavy rolled steel, instead of the more expensive forgings needed for larger nuclear reactors.



Nuclear-grade graphite is required for the fuel blocks and reflector blocks of the GT-MHR, and the United States has the manufacturing capacity for this. Here, machining of a large cross-section graphite block for use in electrolysis cells.

No, and so you have to look at a way of avoiding those forgings, and I think machined steel plate is the way to do that. Keep in mind that the characteristics of the forgings or steel plates should be different between a water reactor and a gas reactor: A water reactor cannot sustain a leak, because if you lose water as a coolant, you can have a meltdown. But in the gas reactor you cannot have a meltdown, because of its inherent safety.

So I think there's a production capability for the vessels, with a combination of rolled steel and steel plates that are machined.



A close-up of silicon carbide, used in coating the TRISO (tristructural-isotropic) fuel particles for the HTR.

Then you go to the *graphite reflectors.* There's plenty of capacity in this country to produce nuclear-grade graphite. It's very pure and it can't burn. The industry has plenty of capability for turning that carbon into something useful, namely *reflector blocks* for the reactor, and also the *fuel blocks.* So, that's a matter of mobilizing the resources that are already out there to produce carbon logs. They have to be machined, and there is plenty of machining capacity for that.

Then you get to the *fuel.* There are all kinds of places that you can make fuel. The tiny ceramic fuel particles have to be produced in great quantity because they are about the size of a grain of sand. But the processes for doing that have been around for many years. We produced fuel at our site in San Diego many years ago in huge quantities. And between the nuclear fuel manufacturers around and the national laboratories, there are enough places where you could produce the fuel. Obviously, the fuel needs to be tested, and the quality needs to be controlled rigorously, but we have almost 50 years of experience now with ceramic-coated TRISO fuel particles, and that's a darn good base from which to operate.

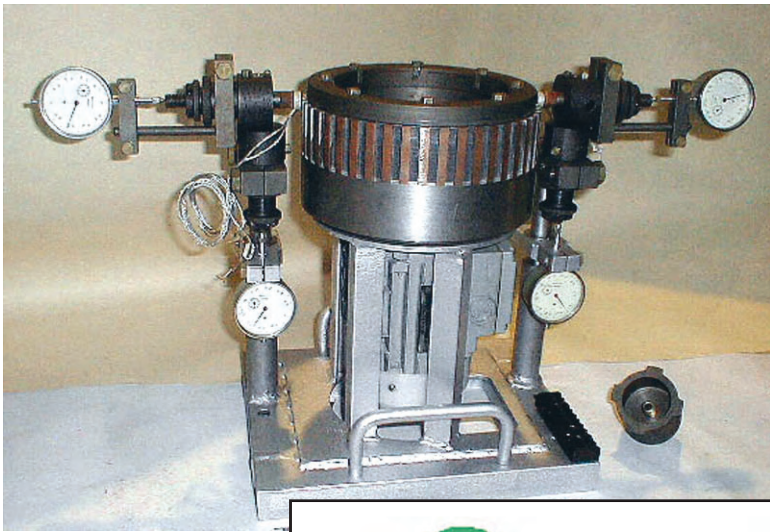
Then you go to things like *control rods,* which are very straightforward. The gas reactor can shut itself down automatically even without the control rods, because of the negative temperature coefficient, which means that if the reactor heats up over a certain point, it will shut itself down. The control rods are just a simple mechanical device.

And then you get to the *power conversion module,* the turbine. You can think of it as a jet engine, which instead of having a big fan on the front, it has a generator. That turbine operates at lower temperatures, lower speeds, and lower stresses, and far, far fewer cycles (the things that sometimes wear out engines) than jet engines do. And also they are not subject to weight sensitivities as jet engines in airplanes are.

So it's a relatively unchallenging use of turbine technologies to produce turbines for high-temperature reactors. The engineering codes for designing the turbines are well established, as are production techniques.

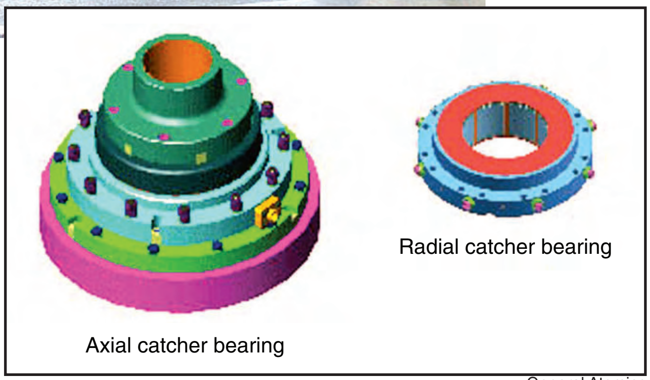
The exercise then is to build a turbine that takes a hot gas, which turns the turbine, and that is attached to the generator. On the other end of the jet engine is the compressors. These compress the helium gas, and then send it back on through the reactor for another load of heat energy—in a continuous cycle.

When you ask the turbine manufacturers if there's high risk in that part of the power conversion module, they say, "No, there's very low risk." The turbine guys say that there may be risk in the reactor design, but not in the power conversion module." By



General Atomics

Electromagnetic bearings on a test rig. Because there is no friction, there is almost no wear on these bearings. Inset is a drawing of the catcher bearing used with the electromagnetic bearing in the unlikely case of an electricity outage.



General Atomics

contrast, our reactor guys, who have been working with the reactors for almost 50 years, say, "Well, no, the reactor isn't risky at all, after all the work we've done over these 50 years, but we don't know about the power conversion module."

Obviously, you have to form a team that has all the necessary disciplines to deal not only with the reactor, but with the power conversion module.

And when you get into the capability to build the turbine, there is Rolls Royce, General Electric, and other turbine manufacturers. There's plenty of capability out there to do the rotating machinery.

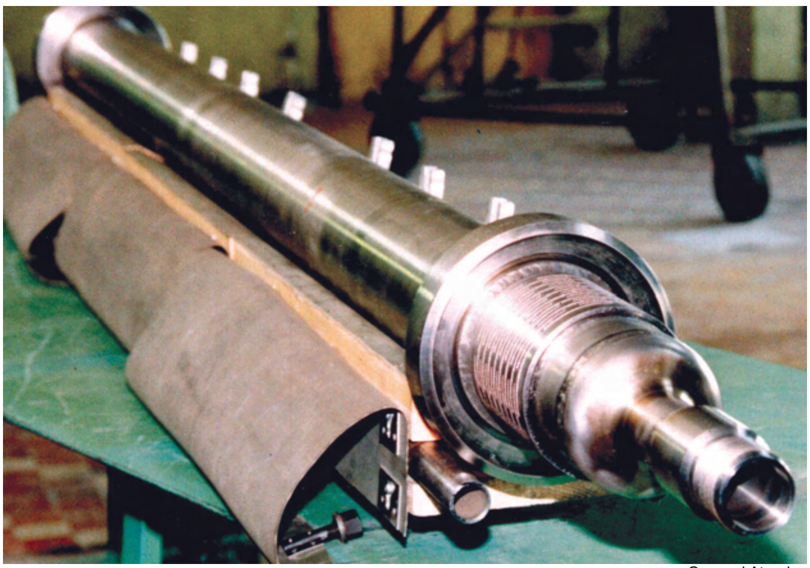
A critical element in the power conversion module is the *bearings* for the turbine. Magnetic bearings are a state-of-the-art bearing system, which was not available 20 years ago, but are in common use today, particularly in gas-pumping booster stations. Magnetic bearings are a far better solution than the oil-lubricated bearings that we used in Peach Bottom 1 [the high-temperature reactor in Pennsylvania in the 1960s], which worked just fine, and better than the water-lubricated bearings that we used in the circulation pump in Fort St. Vrain [the Colorado HTR which operated 1976-1989], which worked very poorly.

The Achilles' heel at Fort St. Vrain was the water-lubricated circulation bearings, and we simply don't have those problems with the magnetic bearings. Magnetic bearings are a very elegant technical solution for bearings, just like the turbine itself. Magnetic bearings have almost no wear, because there's no friction.

The art in using magnetic bearings is having a *catcher system* in case the electricity goes off, for any reason. Of course, that's extremely remote, because you have back-up batteries, and a back-up source of electricity. But even in the case where there was a total loss of electricity, the catcher bearing solution is something that's very susceptible to good design.

The *generator* is very straightforward. There are all kinds of generators everywhere in the world, so that's not a problem.

The *recuperators* in the system are just heat exchangers, and the science of heat exchangers has progressed mightily in the last 20-30 years, and so the *plate fin recuperators* are very efficient and relatively inexpensive. They are not susceptible to the problems of the leakage in heat exchangers, because you are just leaking helium to helium, and if you have a small leak, it doesn't go outside of the system; it remains inside the pressure vessel. It only shows up in a small loss of efficiency.



General Atomics

A recuperator, the type of heat exchanger used in the GT-MHR, is highly efficient, compact, and relatively inexpensive.

So you take all these technical aspects, which some people might think of as challenges, and you examine them item by item, and you see that the industrial infrastructure is there, the technology is there, and it's just a matter of matching the industrial infrastructure and the technology to the money to get a prototype built.

And once a prototype is built, and it has proven its reliability, then people will look back and say, "Gee, this is obviously a much better technical solution; why didn't we do this years ago?"

Question: It sounds like the manufacturing capability is there, at least in concept, and some of it is operating already in the U.S. and elsewhere. But we're missing that crucial element of *political will* here, and we need that to get this done.

That's true. But here the gas reactors have real advantages. First of all, I think it's much easier politically to deal with modules of 100 megawatts, rather than reactors of 1,200 megawatts.

Number two: it is the safety characteristics that any community can get their arms around and understand. A high-school physics class can do the calculations, and they can see that you simply can't get to temperatures that can fail the fuel, so you can't have a meltdown and you don't need an evacuation area, as some reactors do. So, if there's nothing to evacuate, you don't need an evacuation zone, and they say, "That's the kind of reactor we would like to see. And because it assures low-cost electricity to our communities and factories, and a good industrial capability, we look at all the alternatives, and see that this is a better alternative than coal or oil, or even than other nuclear."

American people are smart, and if all the facts are laid out to them, and they can see that this really is a different kind of physics that governs these reactors, then they say, "Yes, this is better than the alternatives."

We all know that we need energy. Energy is what advances civilization and living standards, and this looks like the best source of energy there is. Even horses cause a certain amount of pollution.

Question: Quite a lot, if that's all you have for transportation. . . . I think other countries, especially in the developing sector, are particularly interested in this reactor, because it can accommodate to a smaller power grid, and be added onto as the grid increases.

That's very important, and obviously that is a much better solution.

Also, because of the modularity, maintenance is easier. All reactors require some maintenance. Obviously if you have a 1,200-megawatt reactor, and you shut it down for maintenance, you've got to replace it with 1,200 megawatts from something else. In the case of a modular reactor, any place that you have a bunch of them, you can just shut them down for maintenance one by one, and the amount of power that you're losing is so small, that you don't have to have a source of back-up power. That is a significant factor any place you put them, but particularly in small countries where they don't have a grid where they can bring other power in.

It's a far better way to handle the electricity load of a smaller country. It's far better because you're not dealing with a safety equation which absolutely demands that everything be perfect all the time, and so you can see this kind of technology being employed in Third World countries where you probably wouldn't want to have a large light water reactor.

Question: Well, a large reactor would overwhelm the grid of most of those countries. . . . You mentioned at the HTR press conference in Washington that you thought we could be producing 60,000 of these reactors, and I wasn't shocked by that number, because we've estimated that the world will need 6,000 reactors of 1,000-megawatt equivalent by the year 2050, just to keep up with the growth in electricity demand. So, how do we get this going?

We simply have to build a demonstration reactor. And then once it is demonstrated, and once people understand that it's real, and they see the economics of it, and see the safety of it, then there will be just overwhelming demand for it. That's the kind of challenge or problem that every manufacturer loves to see. It's a lot easier to produce things in quantity, than it is by single units.

So, getting the money matched with the technical capability and getting the first one built is what it's all about.

Question: There is a demonstration reactor being built, in South Africa, of the PBMR pebble bed variety, so it would make sense if here, under the NGNP, the Next Generation Nuclear Plant, we go with the GT-MHR type of high-temperature reactor. But, NGNP is a very "slow boat" at the moment.

I agree. NGNP would be a very good thing to do. I think that this technology is ripe for the private sector to take it up and do it. . . .

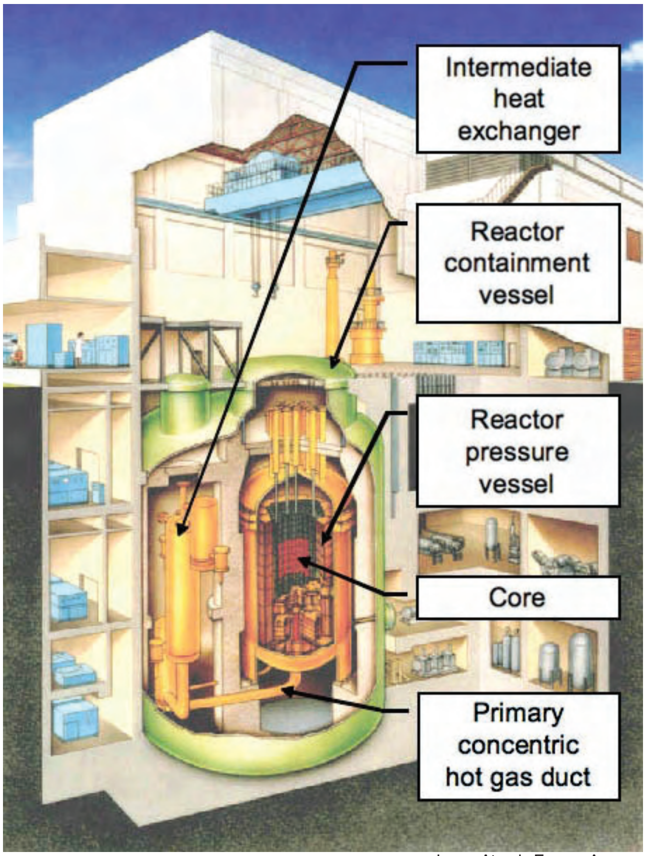
Question: What about Russia? You have an engineering program going with the Russians on the GT-MHR. Can they put any funding into it, in terms of building a prototype there?

The Russians have been collaborating with us for quite some time, in work on a plutonium disposition program [burning up weapons plutonium], which everybody wants to see happen. And the Russians do a superb job of designing and engineering and the physics. They have a good background in this technology. So I think collaboration with the Russians on this could be very real, and has good potential.

The demand is great enough, so that there should be a lot of participants in this kind of program.

Question: The Russians seem to be moving faster in terms of putting new reactors into motion. Of course, they are building industrial-size conventional reactors and fast reactors.

That is true, and exactly what their rate of speed will be as



Japan Atomic Energy Agency

Schematic of the HTTR, Japan's 30-megawatt high-temperature demonstration reactor, which has a prismatic block core.

Japan Atomic Energy Agency

Sintering fuel particles for Japan's HTTR at the Nuclear Fuel Industries, Ltd.

they deal with the lower price of oil, I don't know. The Russians have their own economic problems right now. We have found the Russians to be very good partners in the plutonium disposition program, and that could very easily be converted to a development of a civilian power reactor.

Question: What's the estimated cost of the first reactor, the demonstration reactor, and what would the cost be when you're in mass production?

I believe that the first module could be built for between $600 million and $1 billion. That's my estimate. There are some estimates that are higher, but I think that when you apply manufacturing disciplines to it, and keep things simple, that would probably be a realistic number.

When you get into mass production and come down the learning curve, I think you're looking at less than $2,000 per kilowatt, or about $200 million for a 100-megawatt reactor. Right at the moment, that's actually a lot better than the big light water reactors. So, at that kind of a rate, you really have something that is very economical.

The other thing that the world is going to see is more electric vehicles, and this kind of reactor would be an ideal way of producing electricity to power electric vehicles. Essentially, you could fill your electric tank at home at night for the equivalent of 75 cents per gallon; that's really attractive. Many people who are now paying $3 to $4 per gallon would be overjoyed to be able to charge their cars at night for 75 cents per gallon of gas equivalent.

Question: It's also very convenient. But you have to have that electric power grid.

Yes, and you have to have that off-peak power—that's between 11 PM at night and, say, 5 AM. With nuclear plants, you don't want to shut them down. It makes sense to sell off-peak power at a lower rate, particularly to charge electric cars.

Question: I think the problem we face now in this time of financial collapse is that we need a Franklin Roosevelt approach.... And a critical part of this is building nuclear plants. You really don't have a future without nuclear.

That's right: Modern industrial societies need power, lots of it. Solar will come along; wind can provide a little bit. But the heavy lifting can only be done by hydrocarbons or nuclear.

Question: And we want to save the hydrocarbons for other uses, not just burning them up. Nuclear is an optimistic way to look at how we can build ourselves out of this collapse.

Yes. It's basic production, not paper streams of profit. It's adding basic energy for production. Building such plants would put a lot of people to work. It would obviously do good things for the construction industry. It would have a huge effect throughout the economy to have a major surge in building these plants, and it would save the $7 billion a day that has been going from the industrial world to the oil producers. That was the figure at the time that oil was at $120 a barrel, so it's less than that now. But even so, there's a huge transfer of wealth to the oil-producing countries. HTRs would dramatically change that.

I think I told you my theory for what the potential of this is. Right now we get 20 percent of our electricity, but only 8 percent of our *total* energy from nuclear. If we go to the French example of producing 80 percent of power with nuclear, that would raise us from 8 to 32 percent of our total energy, just by itself. That would create a huge difference in our oil consumption and natural gas imports.

Then, if you assume that we could provide half of the transportation fuel by using electric vehicles, and then half of the process heat from this kind of nuclear—and you know because of the higher temperatures, we can do most process heat applications that the lower-temperature nuclear reactors can't do. So between the French example on electricity, and half of the transportation and half the process heat, you're up to the potential electricity from nuclear to 62 percent. That would almost eliminate our balance of payments problem. To say nothing of getting the price of oil and gas down to realistic levels. It just has a huge effect. The environmental advantages would be another big bonus.

General Atomics

The dedication of the Peach Bottom HTGR Atomic Power Station in 1967. From left, Lee Everett and R.G. Rincliffe, Philadelphia Electric Co.; Atomic Energy Commission Chairman Glenn Seaborg; and John Kemper, Philadelphia Electric Co.

Question: I think there are also the educational and cultural effects of going nuclear, because when you have a society moving forward like that, it gives kids a future. Now what do they have—training to run a windmill? We're going backwards.

It could give a lift everywhere. Right now we're mortgaging our future, buying all that oil, and the HTR is a real alternative.

Question: We could be producing hydrogen too, as a fuel.

Yes, that comes next, and that has significant potential. I think in the short term, the electricity for vehicular transportation makes sense. You already have the electrical grid for distribution.

People could see that instead of sending all that money to oil-producing countries, we could keep that money inside this country. Nuclear has no pollution, as with burning hydrocarbons. That's a better way of doing things. So what's the negative here? The answer is *inertia*! We've got to get it done!

Question: I have an historical question now. When did General Atomics get involved with the high temperature reactor?

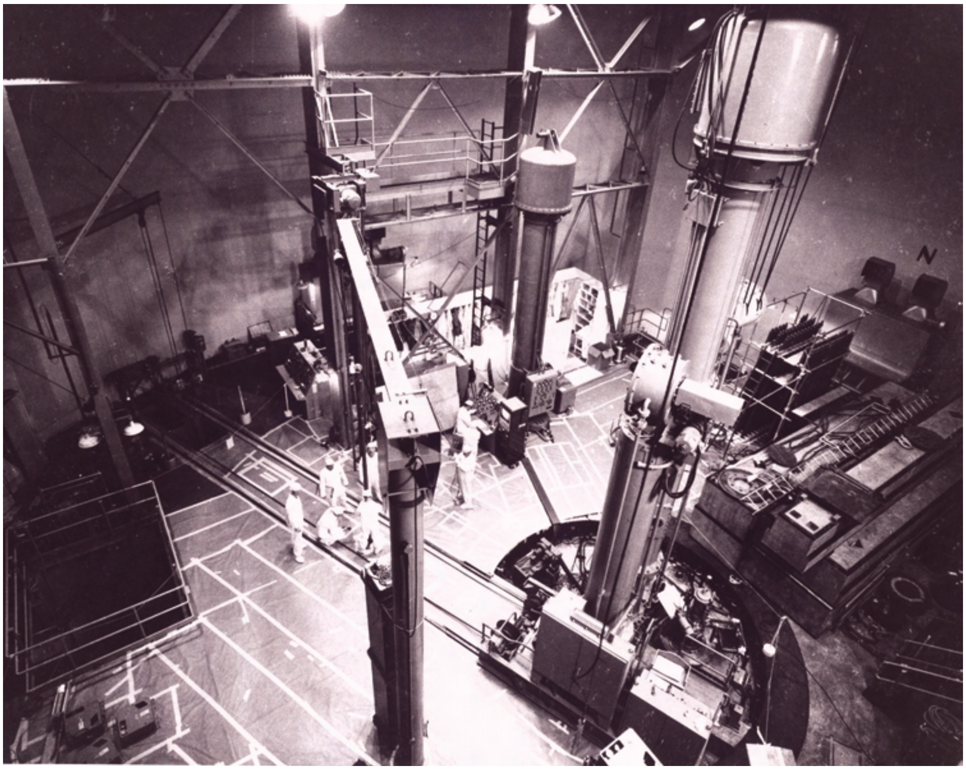
It was about 50 years ago. First of all, General Atomics was founded for the peaceful use of nuclear energy. It was back in the Eisenhower Atoms for Peace era, in the middle 1950s. And you had a lot of very smart people, who asked, "What is the best way to do this?" And they said, well, in submarines you obviously need very very high power densities, greater power output per reactor vessel size, because space is at such premium. But for terrestrial applications, the primary criterion should be the ultimate safety. And how do you produce the ultimate safety? You make *ceramic fuel*, not metallic fuel, and you use helium coolant instead of water, because helium is a noble gas and doesn't corrode.

Of course, back in those days we were still using a Rankine cycle, and it wasn't until the late '80s or maybe early '90s that we decided the technologies were mature enough to do a Brayton cycle. But since that period we've felt that the direct conversion Brayton cycle was the thing to do.

So it's been in that 50-year period that we've been evolving the HTR, and everything has been improved, from the fuel, to the jet engine-like turbines.

We have also had a major setback with the Fort St. Vrain capacity factor. It was never a safely issue; it was a hydromechanical problem, not a nuclear problem. We just screwed up in the design of those lubricator bearings. The water could get into the reactor, and so they would have to shut the reactor down to drain it out. So magnetic bearings are a huge advance.

Technology is a wonderful thing! People invent better things to solve problems. And this is exactly what's happened here. Over this 50-year period, the reactor design has improved dramatically. We've made mistakes, and we've cured them. And now we have something that is so safe, and so economical, and



The General Atomics Reactor operating floor during fuel loading at the prototype Peach Bottom HTGR, 1966. Peach Bottom, operated by the Philadelphia Electric Co. at Peach Bottom, Pennsylvania, successfully supplied power to the grid from 1967 to 1974.

so efficient, and so non-polluting, that its time has come.

Question: Yes, it's overdue. in fact!

Well, you recognize that, and what you're doing is drawing attention to the problem, and you're saying, "Hey, there is an alternative, there is a solution." All too frequently people say, "There's no way to deal with this." Well, there *is* a way to deal with it.

Question: The PBMR people proposed for Africa having regional centers to train engineers and technicians and perhaps a continent-wide regulatory agency. Have you any thoughts on that?

That could be a good solution for Africa. I think that the U.S. is the gold-standard for nuclear licensing, and I think that there's plenty of residual capability in our universities to properly train people, so I don't look at that as a major problem. One of the reasons, again, is that this is such a simple system. You want to have experienced people running them, but if you have people with less experience, they still can't mess them up—in the way human beings messed up at Three Mile Island and Chernobyl. It's just inherently not possible for human beings to cause meltdowns in these modular reactors. So obviously, you do need to train a lot of people, but the U.S. has a great labor force to work with.

And then you need a lot of computer-savvy people running them, and that's sort of everybody in the current generation. Because increasingly Moore's Law is going to govern nuclear control, just like it does everything else, where you have the vastly greater capability to control machines electronically. You also have much better systems for safety.

Question: What's Moore's Law?

Gordon Moore, the visionary head of Intel, many years ago said that computing capability would double every 18 months. Now he said that 20 or 30 years ago. Well, it has worked like clockwork. When you have that kind of a compound improving effect, you have a dramatically increasing capability. That's what's happened in computers, and that's why the world is increasingly driven by computers. And controlling nuclear reactors is just an absolutely ideal application for automated electronic controls.

Question: But you still need that human element.

You still will have that human element. You enable the human beings to do a much better job. It's like flying an airplane, which I know something about. Right now, because of the electronics that Moore's law allows, it's almost impossible for a pilot to lose what we call situational awareness, where they become confused and they don't know exactly what's going on, or where they are. These advanced electronic systems make everything dramatically easier and therefore much safer. And that's one of the reasons you're seeing such an improvement in aircraft operations, and the same thing can be done with reactors.

Question: I wish that there were a similar "law" about mass production of nuclear reactors. . . .

Well, you don't have Moore's law in all areas of production, but you do have the benefit of it. Since there's a lot of electronics in any sophisticated power plant, you get a lot of benefits from the miniaturization, the redundancy, all of the advantages of modern computing, so that's a big reason why it makes sense to have *modular* reactors, because you can have a standard set of electrical controls, and the price of those controls further reduces the price of reactor modules and their operation.

INTERVIEW: JACO KRIEK

South Africa's PBMR Is Moving Forward!

Marjorie Hecht

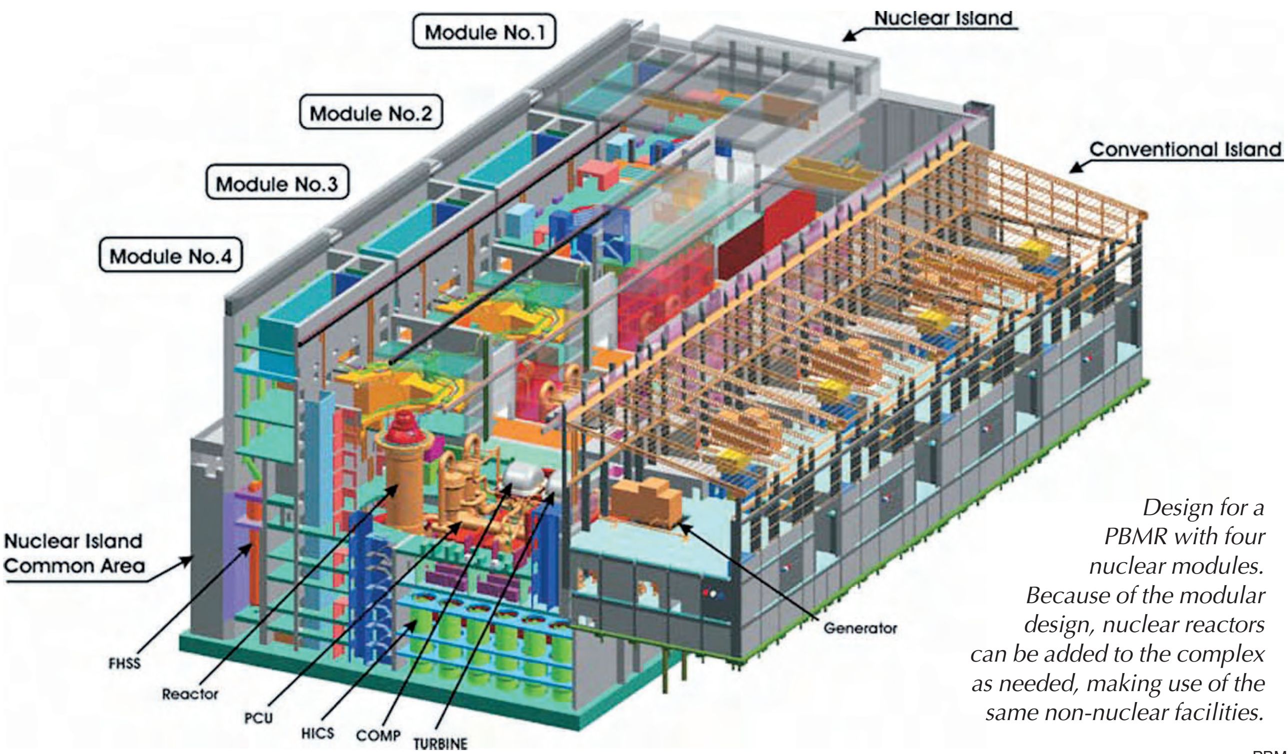
Jaco Kriek is CEO of the Pebble Bed Modular Reactor (Pty) Ltd. in South Africa. He was born in South Africa, Kwa-Zulu Natal, in a town called Vryheid and raised on a game farm bordering the Itala Game reserve. Before joining PBMR in 2004, he was executive vice president of South Africa's Industrial Development Coporation, responsible for mega-projects, including the PBMR, the Mozal Aluminum Smelter, and others. He was interviewed in Washington, D.C., by Marjorie Mazel Hecht on Sept. 29, 2008.

Question: To me the PBMR represents optimism, not just for South Africa but for the whole continent. I see both the PBMR and the General Atomics GT-MHR as the "workhorses" for what we need for the future.

How do you view the PBMR and its role in terms of transforming South Africa—its economy, its industries, and it workforce?

"PBMR is one of the few engineering and science megaprojects South Africa has. We should not waste that opportunity. It's an opportunity in a lifetime for a developing country."

I think the impact and the potential for gas reactors has been kept alive by PBMR for many years, at a time when nobody wanted to touch it, and nobody was interested in nuclear. Now there is a nuclear revival, and you see a lot of others coming along, that were in the business many years ago. We are not just a small local entity. Already South Africa has created a nuclear industry, although it's still young. We have the U.S. Nuclear Regulatory Commission coming to our regulator to learn how our regulatory licensing is coming along. There was a visit a few weeks ago, a delegation of about 15 people from the NRC, visiting our test facilities. And we've got an ASME workshop next week—the American Society of Mechanical Engineers—because our design is based on ASME standards, and we had to make some additions to the ASME codes and standards—ASME Plus. So ASME is engaged with our regulator.



Design for a PBMR with four nuclear modules. Because of the modular design, nuclear reactors can be added to the complex as needed, making use of the same non-nuclear facilities.

PBMR

In South Africa, we've kept the nuclear idea alive—in public opinion—and therefore when the state utility Eskom just announced that they were going to build a number of large reactors, there was no outcry. The country's citizens almost have an attitude of "We knew it was coming."

When you talk about local industry: we are now busy with about five local companies, to get them ASME accreditation, so that they can manufacture nuclear-grade components for us. We have agreements now with six universities, and we're increasing the number, to include nuclear engineering as a subject. Last year was the first year that two nuclear engineers qualified for PBMR bursaries. In addition, we have research projects with those six universities.

PBMR

The PBMR Helium Test Facility at Pelindaba is testing many of the plant components in a helium environment. The non-nuclear facility is designed to test helium at the high temperatures and pressures that will be experienced in the Pebble Bed Modular Reactor.

And we have created the Nuclear Industry Association of South Africa. Areva, Westinghouse, Mitsubishi Heavy Industries, and others—Eskom, Uranium One, Necsa—are members now. It's grown tremendously, and all the big local companies have joined. Its purpose is really to consolidate all the initiatives—education, regulatory issues, manufacturing, licensing, industrial capacity, government liaison, policy issues.

So PBMR is a substantial local industry. We have over 800 people locally employed, and worldwide we probably have 1,800 people involved in the PBMR program—suppliers, universities, and in departments of government.

Question: You are producing the first of a planned series of a new kind of reactor. What stage are you at now?

We have basically had to handle a number of challenges. This is the first time South Africa is licensing a nuclear reactor. It's a first-of-a-kind reactor. We've got the issues of conventional PWR [pressurized water reactor] safety philosophies, and we measure accordingly. This is a new concept, with new characteristics—inherent safe characteristics, meltdown proof. It's different, and for us, we have to justify on paper that it's different, and that the regulator should accept what you say on behalf of the public that it's safe, without having a reactor built. Obviously there have been other similar reactors. But the regulator wants to see what you're going to do, how you're going to operate it safely. That was the challenge for us.

Because South Africa didn't have a nuclear industry or a nuclear policy, the government didn't really know how to handle this. Remember, it was originally Eskom that started this initiative.

So, we at PBMR were a bit like a young elephant bull. We've got a lot of elephants in South Africa, and they relocate them. But what they found is that if you relocate only the youngsters, they have no discipline. They go wild, and they actually attack rhinos, and cars. The matriarch is the one who imposes and keeps discipline. So we were without a "matriarch"! And therefore, we made mistakes with our regulator—lack of respect, let's say for the nuclear safety culture, for the regulatory requirements, for the customer.

But I think that the "matriarchs" that we got involved, for example, Westinghouse, IAEA [International Atomic Energy Agency], INPO [Institute of Nuclear Power Operations], to help us, and a lot of work inside PBMR, helped us to understand and to really get a nuclear culture. We were a company that was put together by people from the arms industry, utilities, and some from the old Atomic Energy Corporation of South Africa (currently Necsa). So, in the arms industry, you build a cannon and you test it. It's a different culture.

With nuclear, the knowledge and expertise are there, but it's how you do it, the paperwork, the procedures to follow, So those were challenges. And I think in hindsight, the disadvantage was that we were not part, for example, of Areva or Westinghouse. We were not part of a "mothership" that looks after you—people, processes, funding. We were created from scratch. Now the benefit is, we've got a unique culture, a young company. . . .

Question: New ideas. . .

Exactly. So that's the benefit. But it was a rough grinding to get to where we are. And sometimes people say, "Why did it take so long?"

First of all, we had to create a company, and build two projects. Even for Areva, building the conventional Olkiluoto reactor in Finland, this is challenging—with their stop work or-

PBMR

Wildebeest and zebra grazing near the Koeberg nuclear site, where Eskom, the state utility, operates two 900-megawatt pressurized-water nuclear reactors, the only nuclear reactors on the continent. The PBMR demonstration reactor will be built near here. Koeberg is on the coast, near Cape Town.

ders, etc.

So now, when you say PBMR, they assume there's a company, an order department, a licensing department, risk management, finance—that all those things are in place, at the same time that you're running with the technical aspects.

And now the latest status: We will start to produce graphite at SGL Carbon in Germany in the next month or so. This is for the core structure, the ceramics.

That was a breakthrough for us, because there was no benchmark for the quality of graphite required, no ASME standards. So we had to develop our own criteria and specifications that the regulator would accept. This was tough. But now that has been accepted, and we have a machining facility ready where these big one-ton blocks of graphite will be cut and machined for the core structure.

We also got approval from the regulator to start the welding for the pressure vessel; we've got the big shells, about 900 tons of big shells.

Then on the forgings for the core barrel. Some of the pieces have been forged, and we're now racing to get the welding for that done.

For the turbine: We want to start forgings for the turbine casings and we want to start to make the blades.

So, on the long-lead items there's been a lot of progress, but it's been a long process.

Question: When will you start to build the demonstration reactor?

We want to go on site by early next year, for the early work, the non-nuclear construction. And then in 2010, we want to start the nuclear construction. This is subject to our getting a nuclear construction license and a successful regulatory decision on the EIA, Environmental Impact Assessment.

We are starting public meetings now in the next few weeks, and hope to conclude those by the end of the year.

We hope, and we are confident—but it's not in our hands—that we will get a positive decision in the EIA by the second quarter of 2009. Then we've allowed time for appeals and legal processes to conclude, and we hope by the end of next year that we have a decision from an environmental point of view that will allow us to go to site.

Now we also have to still convince the nuclear regulator that we can go to site, because there are certain issues in the Nuclear Act—One thing I should mention is that our Nuclear Act was not designed for new builds. It was put in place after the Koeberg Nuclear Plant was built, so it was designed to *maintain* nuclear facilities, not to build new ones. If there is an issue at Koeberg, the regulator does not shut it down; they will say, "I want you to improve on this or that." But we can't start to build until all the issues are resolved to the regulator's satisfaction.

It's a different philosophy.

Question: How is your regulatory agency put together? Is it appointed by the Parliament?

Yes, it reports to the Department of Minerals and Energy, more or less the same as the U.S. Nuclear Regulatory Commission. It's a board that's appointed by the Minister, so it is an organ of state. And also a lot of work has been done by our self capacity for cooperation, like the NRC. The National Nuclear Regulator, or NNR is part of MDEP, the Multilateral Design Evaluation Panel for regulators. When there is a new design, like PBMR, the regulators cooperate. So the NRC and the NNR cooperate on PBMR.

Question: What will be the effect of the change in government for the PBMR? Do you anticipate a lot of changes?

I don't think so. I don't want to sound arrogant or blasé about it, but we've done a lot of work for the transition. It's still the ANC [Africa National Congress] that is in power, not a new party, so the policies on nuclear, on the PBMR, should stay the same. The next ANC conference will be only in 2012.

From the work that we've done, PBMR is one of the few engineering and science megaprojects South Africa has. We should not waste that opportunity. It's an opportunity in a lifetime for a developing country. SASOL [South African oil from coal company] was another example, and there are very few of those companies in South Africa that can play on the global stage.

As a country, South Africa is way above its weight division in terms of what we're doing. But the circumstances were just there—we were in the right place at the right time to get this technology and take it further.

So, I don't think we'll see changes. Obviously for a developing country there are lots of requirements on funding: infrastructure, social welfare, job creation. But what we're saying is that there's a very direct link between science and engineering projects and anti-poverty measures. Science helps with antipoverty. It helps raise the standard of living for people.

Question: Traditionally, you need a science driver, if your economy is going to grow. A lot of people don't understand that.

Exactly. I've gone around to all the universities, to talk to the vice chancellors, to get them to cooperate with us, saying, "You need to help us to make this link more visible, and clarify it, and explain it. This is something that you should add into your communication and education about science and engineering."

PBMR is a good example because of the spin-offs. For example, we have the fastest computer in the Southern Hemisphere to work with our modeling and to test PBMR systems and equipment. These computers produce models in the *virtual world* that accurately predict and analyze the impact of the strains and stresses the demonstration plant will be subjected to when it goes into operation in the *real world*. This is totally different from nuclear—it's a different field, but the university can now have students and train them in it. Materials, measuring temperature in the core, these are not nuclear, but all these technologies and research are around our technology. And there are many applications. Flownex, for example, is a code that was designed for PBMR, and is now being used by SASOL in other areas.

And companies were established because of PBMR that are now servicing the economy in other areas.

It's an educational process, that we now spend a lot of time on. We have to continue this with the public, because those people who can't see the link, will claim that we are a "white elephant." That's the last thing we are. We're an asset to the country, a pool of expertise and skills.

Question: The country really has no future without nuclear. You have blackouts now with the power supply. You have enormous unemployment.

And if you think there's a magic way of getting out of that, without development, without research—nothing comes for free. You have to invest, if you want to get something out for the economy.

This satellite view of the African continent at night gives a striking picture of the lack of electricity. Although the continent has 12 percent of the world's population, Africa accounts for only 2 percent of the world's energy consumption. More than half of Africa's electricity is produced and consumed by South Africa.

Question: But it has to be real, productive investment, not paper.

Yes—the taxpayer gets a third of that money back that is invested in these projects; it's spent on the people.

So, really, in my mind, one thing that has happened that I think is really positive, and maybe not noticed yet by the international community (maybe it has been, but I really don't see it) is that here in an African country: the President is asked to resign, and constitutional processes are followed, legal processes, and there is no violence. The next President is appointed three days later. The cabinet is reshuffled, new cabinet ministers are appointed, and life goes on.

It's interesting, I think we're in good company, because your President is about to change!

But unfortunately, because of the African connotation, people think that if there's a change, it's going to be another Kenya or Zimbabwe. I think South Africa, the South African market, the South African economy is just too strong, and I think it's been demonstrated that we've started to mature as a democracy, which is very positive.

PBMR

South African pioneers of the pebble bed technology. From left, Dave Nicholls, first CEO of the Pebble Bed Modular Reactor (Pty) Ltd. (now with Eskom), Dr. Johan Slabber, and Dieter Matzner.

Question: It's positive for the whole continent, and perhaps you can say something about that—the role of the PBMR in transforming all of Africa.

Yes, we're talking to our regulator in fact, we're putting a few people at the University of Pretoria to study nuclear law and specifically to set up regulatory frameworks in other countries.

Question: Many African countries are interested in going nuclear—about 20 of them.

Probably initially we will need an African-wide regulator. It's too expensive, too complex, and probably too risky to allow every country to have its own regulator. I don't want to sound like the U.S., or that we need to control it, but I think Africa needs to do that.

Then you have to make sure that the operators are qualified internationally, that waste issues are handled. But I think the fastest way for Africa to get nuclear is to have a very credible regulator—an African regulator with international operators.

If you look at the African grid, South Africa produces and consumes more than 50 percent of the electric power.

Question: You see that in the satellite map of Africa at night, a dark continent, with just a few spots of light. . . .

Exactly. So if you look at other countries in Africa, some of the grids are 900 megawatts, 1,000 megawatts. To give you an example: I was involved in Mozambique with an aluminum smelter. It's a 1,000-megawatt plant. It uses four times the electricity of Mozambique, just that one project. So these small 165-megawatt PBMR reactors are ideal for these countries.

Question: It's a start that can grow with their power grids.

Yes. As somebody said in Mozambique, they use diesel fuel to generate electricity, so cost is not an issue. Even if you think that nuclear will get more expensive, it will never reach the cost of diesel. And then there's the logistics of the diesel fuel.

So it's a challenge for Africa. But South Africa is serious about this. We have a visit to Tunisia next week; they want to understand how they can cooperate with us. Algeria, Morocco, and Libya are also interested in the technology.

Question: These are places with nuclear research reactors, where there already is training of students.

Exactly. So, you'll probably find that we'll cooperate from the South with the North, Northern Africa, and we'll try and see what we can do. Some of these countries want to establish nuclear training schools with South Africa, and invest with PBMR potentially. So I think that there's a lot of potential. And that's just on the extrinsic side.

PBMR

Inside the PBMR Helium Test Facility at Pelindaba.

And we are not just talking about producing energy. We are heavily dependent on imported oil, but we've got all that coal. However, 60 percent of our coal is burned, just to make oil from the coal. SASOL, for example, claims that they can extend our coal reserves by 25 years if they don't have to burn 60 percent of the coal to get the oil out of the other 40 percent.

So I think that combination makes so much sense for us to go with the PBMR.

Now if you look at the energy situation in the world, the oil price, CO_2—and we're not saying anything on the CO_2 situation—but we can see in areas of South Africa where there are coal-fired power stations, it has an effect on the health of people.

Question: The emissions.

Yes. Worldwide, climate change, we're not saying we need PBMR for that. We're saying: Let's get clean energy. Let's get security of energy supply, because coal is not going to last forever. Oil is not going to last forever. So let's use all the energy available to us with as little impact as possible on the environment. That gets us to nuclear. I'm not saying only nuclear, because it's not realistic. We will have to continue to use coal.

We need to build 40,000 megawatts in the next 20 years. It's impossible to just build nuclear stations. We'll just run into trouble. Not just because of cost, but because of time, the schedule required to get licensing, to complete construction. So these are the issues.

PBMR

PBMR's Helium Testing Facility at Pelindaba is testing fuel handling, control rods, and secondary shutdown systems.

Question: Once you get the licensing for the first PBMR, do you have to re-license to mass produce the rest?

Well, obviously then you've got a carbon copy of the technology, and the EIA studies, but you still have to license each site.

Question: But you can put up six or eight plants at the same site?

Yes, sure. The footprint is very small, so you can add a lot of reactors. Again, at this stage, it depends on the customer. For process heat, you're probably talking about two or four units. For electricity, maybe you need more. But maybe you don't, because of the decentralized distribution; maybe a city or an area needs two units.

The distribution has now become an issue—right of way. The transmission lines from the coal-fired power stations in the northern parts of South Africa to the coast in the south are very

When a person is inside, it's a very interesting development. If you think about South Africa: We've got gold, we've got iron ore, we've got uranium, we've got thorium, we've got PBMR technology, we've got companies like SASOL—with the technology of producing oil from coal. We don't have much water to generate hydro-electric power. But you put all that together, and you don't have to study too much to say it makes sense for South Africa to go with PBMR.

long (about 1,500 kilometers to Cape Town), and you lose energy on your transmission lines—up to 20 percent of your energy on long transmission distances. At the moment, Cape Town is dependent on the Koeberg nuclear plants, plus the transmission lines.

And the loss of 20 percent during transmission, means that out of every 100 megawatts, only 80 arrive at the end of the line.

Question: So you really need an upgrade of your transmission lines.

It's happening already.

Now, obviously with the big nuclear stations, you're limited to the coast. So location is an issue. We don't have big rivers that we can locate nuclear stations on.

There is hydro—the Congo's Inga project, but it is 4,000 kilometers away. So we can't rely too much on that. Coal is in the north of the country, and your industrialization is on the coast. So that's where the new big nuclear stations will assist.

But the areas where you've got mining activities are far from everything—far from the coal, far from the coast. So there is a good case for the PBMR, [which doesn't need water for coolant].

I don't think there will be many big changes from the new government on this. Affordability will be an issue—it's always an issue. And we're going to have to make as much progress as we can.

Question: I think the government really can't afford *not* to do it. . . .

What about your relationship with the Chinese? China has built a demonstration pebble bed reactor. Are you working with them?

Yes, they have basically taken over the German design, with a 10-megawatt reactor. It's not a commercial size. We are in discussions with them, and I think where we could cooperate is on the issue of licensing and process heat—they have a lot of coal. One of our local companies, SASOL, is extremely involved in China. The Chinese HTR also uses pebble fuel. We will have to establish where we are each in our program, and what the common areas are for cooperation. Fuel, principles of licensing and safety—those are areas we can cooperate in.

We signed a memorandum of understanding with China in 2005; we're actually meeting them tomorrow to explore potential cooperation. . . .

Question: China has invested a lot in Africa—they are building dams and various other big projects. So it seems that they understand the value of getting infrastructure built in the continent.

But they are not as much in South Africa yet. They are in Mozambique, Zimbabwe, Sudan, and some other West African countries. I think in South Africa, because of the economy, most of the reserves are owned by different companies: Anglo-American, BHP Billiton, big international companies. So I think maybe the space for the Chinese is less. In other countries, like Zimbabwe, the international companies pulled out so there is more access for China. Same with Mozambique.

You know with agriculture in Mozambique and Zimbabwe, they have the potential to feed the whole African continent!

Question: Yes, they could. And Sudan has huge agricultural potential too.

Yes, if they could just get their act together. But one of the issues is distribution, logistics. Another issue is that they are not allowed to export their goods. The duties on their exports are high. The domestic market is small—they have too much for that area. So that's always an issue for small economies.

It also applies to South Africa. If we have a big project like a steel plant or an aluminum smelter, we have to export. Our local consumption is too small. But you have to build a big plant; otherwise it doesn't make economic sense.

Question: My interest for many years has been with nuclear, and with developing the world. And we—the Lyndon LaRouche movement—have proposed the Eurasian Land-Bridge, which would extend from the east coast of China all the way to Rotterdam, to open up the interior of Eurasia for development, new cities and industries. We see the PBMR and GT-MHR as the work-horse reactors for that. We would start with nuclear there, and there is a lot of support for this program.

I think one thing that is not yet taking place is international cooperation. Commercially you're trying to protect your IP [intellectual property] and your lead in the market, but I think that is why it is difficult for companies to cooperate. But *countries* should cooperate.

And now there's a draft agreement between South Africa and the United States on research on new advanced technologies, like PBMR, and with the NGNP, Next Generation Nuclear Plant, we're participating in that program, and with the NRC, ASME. With the U.S., there is a lot of cooperation. But we're not at the point yet where we can share the funding of these projects, to make it easier.

Unfortunately, it looks like there's going to be duplication. In the U.S., they want to build their reactor; we are going to build our reactor; China is going to build its reactor. Japan, etc. And the first-of-a-kind costs involved in building these first ones is so expensive. If we could share that, then it would make it much easier to build the reactor. Then it would be just the materials.

Test facilities—we spent $100 million on test facilities, which I think in hindsight was good. We've learned a lot, and gained a lot of experience from our test facilities. And the U.S. NRC is now saying that they want to do some of their tests in our facilities.

Question: Of course the U.S. shut down its test facility—the fully operational Fast Flux Test Facility. That was really stupid. So, in this case, you are providing leadership to the United

Courtesy of Emerson Process Management

Solvent blending at a Sasol plant in South Africa. Sasol produces oil from coal, a process that requires burning 60 percent of the coal to get oil out of the remainign 40 percent. Using the high-temperature process heat of the PBMR would be far more efficient.

States. Because you're moving ahead, and so far you've had government support. I don't think that situation exists in the U.S. in the same way.

We have a least a three-year window of predictable funding, whereas the DOE programs are funded annually.

Question: The DOE is really a dinosaur.

But if you call them dinosaur, ours is older!

Question: What about the George Soros-funded opposition to nuclear in South Africa?

It is sad that foreign companies or rich people try to dictate or influence policy decisions in developing countries, when in their own country, they are going to go nuclear. It's sad that they don't want to allow *us* to do it, I don't know what makes them feel they should spend money on this. Maybe the trust or foundation doesn't even know that the money is spent on this. Their money is so big, and spent all over the world. The funder doesn't always realize the damage they are doing to South Africa, or to other developing countries.

Because what do you want us to do? Do you want us to continue to import nuclear technology and fuel from the U.S., or from wherever else? Why can China, Japan, France, go ahead with nuclear—but foreign money is used in South Africa for anti-nuclear campaigns? It doesn't make sense to me. But unfortunately, that's how life works.

If somebody has got a conscience, they're going to spend their money combatting malaria in Mozambique, for example. I think the anti-nuclear funders don't really appreciate the damage they are doing.

Question: In some cases, I think these groups intend to damage, because they don't want to see the world go nuclear, for population reasons.

But why don't they do it here [in the U.S.]?

Question: Well, they do! They *do* fund anti-nuclear groups here, and there is an opposition to nuclear here. . . .

But they're not very successful here.

Question: On the other hand, we haven't built any new nuclear plants since the 1970s.

I believe that there are now signs that companies will get combined operating licenses to build new plants.

Question: Yes, but it's very slow. And there was a lot of damage done by this funding going into the anti-nuclear groups.

But because you have 104 active plants, you're a lot stronger on the nuclear front. South Africa is really at the beginning, so the damage to us is much bigger. They are planting doubts in the mind of the public and the government. They say it's too expensive; they call us a "white elephant."

You find some people listening to that. They need to balance the books on the funding, and they ask, "Should we do this for the PBMR?" And now someone from the U.S. is saying it's "stupid." Or "why not build windmills from Denmark."

Question: Well, the Danish are putting funds into the anti-nuclear movement in South Africa.

And why? Because they want to see windmills?

Question: They haven't been able to replace any conventional power plants in Denmark, even though they have all those alternative windmills. Because the windmills don't produce enough reliable energy. . . .

On a different subject: What do you plan to do with the used nuclear fuel. Will you reprocess it?

As far as waste is concerned, so far there is just a low-level waste site called Vaalputs, in an area called Namakwaland.

There already is a policy approved that the utility, at the time when they want to store their waste, and empty the pools, they will have to justify whether they want reprocessing, or long-term storage. So the final decision hasn't been taken yet. And it is in the hands of the utility that will do the economic and technical presentations to the government.

Question: The utility being Eskom?

Yes. Now, there's a bit of waste from Pelindaba, at Necsa, the Nuclear Energy Corporation of South Africa, at the moment, is the custodian of the low-level waste. So Vaalputs is the site, but it's only for very low-level waste. None of the spent fuel from Koeberg has been moved there.

I don't think South Africa will ever put up a reprocessing facility; it's too expensive. France, Japan, and eventually the U.S., are going to go in that direction. But we'll always have to send out our spent fuel for reprocessing. I know the French have already made a proposal to Eskom, because the Koeberg station's sister station in France, is already operating on MOX fuel [mixed oxide made from recycled fuel]. So Koeberg, with some adjustments, can also operate on MOX fuel.

And what's interesting on the NGNP, is that there is now research that high temperature reactor fuel can utilize plutonium from the waste of nuclear weapons.

Question: That's what the General Atomics GT-MHR is doing.

Yes, with Russia.

And we are also looking at waste minimization. We want to recycle the graphite. This is a program we're doing with research at one of the universities, and with the European Union, with SGL Carbon, a German company that is producing our graphite for the core structure and for the fuel spheres.

So that's the picture on waste.

Question: How did you get involved in the PBMR?

By accident! I am a chartered accountant. In my previous life I was with the IDC, the Industrial Development Corporation, as the vice president for mega-projects. Steel plants, aluminum plants, all the big projects were under me, and the PBMR was one of them. And then, when Eskom pulled out from the project as the lead investor, the ex-Minister [of Public Enterprises] Alec Erwin, and my chairman, Dr. Alistair Ruiters, asked me if I'd be on a task team to discuss with the Cabinet ministers how we were going to move the project forward. That was in February 2004, and on May 27, 2004, they asked me to head the company.

It's been fascinating. The big mega-projects experience was very useful to me, because thinking big, was not new to me. But nuclear was totally new to me. Now I know it superficially. I like the industry. And the timing was good, because of the nuclear renaissance. In 2004, it was totally quiet. In 2005, also. But in 2006, we had an HTR conference in South Africa, and you could feel that the nuclear industry was coming back.

So PBMR's timing was good. It was a little ahead of its time for this renaissance. Let's say five years or more. But in the last two or three years, that has changed, and there's a lot more interest now.

We're in a unique situation in South Africa. We desperately need energy.

Question: Yes, you've had blackouts and brownouts.

They claim that the blackouts we had in January of this year cost the economy 50 billion rand.

Question: And what you could have done with that. . . .

Exactly. We could have built lots of reactors with that. . . . And Eskom now has to make a decision on its big reactors, between Westinghouse and Areva. The issue is cost. The nuclear renaissance, in my view, has selected the wrong time to start. Capital investment is high. The penalty is a lot more now.

The question is, will electricity get cheaper? And I don't know for the foreseeable future, because if you look at how many reactors are being built or planned, the demand is going to be there, but the supply chain might not keep up with it.

Question: At the press conference this morning, I raised the question that we're in a complete financial collapse. And what we need is 6,000 nuclear reactors to meet demand—the equivalent of 6,000 at 1,000 megawatts; they don't all have to be 1,000 megawatts.

I think if the industry is convinced that it's sustainable, the capacity will come. But even now, Finland [the Olkiluoto reactor] is late. The cost is enormous. In South Africa, the decision has been postponed. Europe is moving slower than people thought. It's slower everywhere. So, I think industry is sitting back and saying, "OK, I'll enjoy this wave of high prices, but I'm not going to expand. I'm going to wait." They were bleeding three years ago.

Question: What they did is increase the capacity of the existing plants, instead of investing in new ones, because it's cheaper for them—in the short term. They are not looking ahead. They need to be investing now.

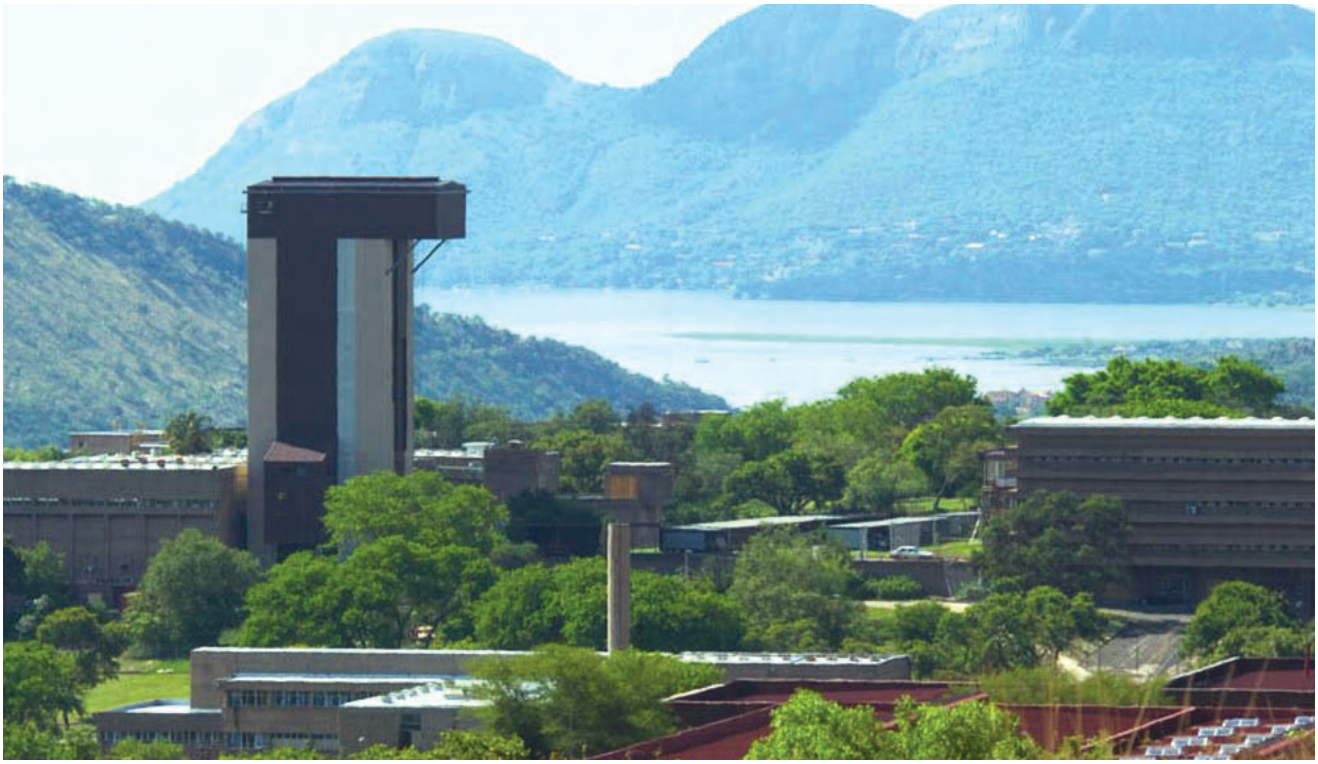
The other question I raised at the press conference is that we really need a new policy, of the sort that Franklin Roosevelt instituted in the Great Depression. The U.S. banking system is collapsing—the $700 billion bailout is not going to do anything for it. It can't—it's a bottomless pit. We have to put these banks into bankruptcy proceedings and start again in an orderly fashion with a New Bretton Woods. I don't see a nuclear renaissance being able to take place unless we have that kind of reorganization.

I think everywhere this is a problem. In South Africa, we've neglected infrastructure—roads, railways, ports, electricity, water.

The problem for us now is in prioritizing funding. You've got real poverty, unemployment, and the unions: When you say, you're going to build a new port, they say, "What for? We need jobs." And this short-term mentality and inability to plan will always try to make this new port look bad. It's big infrastructure, it doesn't create jobs.

But that's absolutely wrong. It's that link, the link between good roads, ports, railway lines, water. . . .

So it's an interesting debate. You also have the element of the government that will try to say to the public, these guys are creating white elephants. "It doesn't create jobs for me so therefore


PBMR

The Pelindaba site of the Helium Test Facility, with the Hartebeespoort Dam in the background. The 43-meter-high facility was built to test the helium blower, valves, heaters, coolers, recuperator, and other components at pressures up to 95 bar and 1,200°C

it can't be good."

Question: Where do they think the new jobs are going to come from, if not from advanced technology?

Unfortunately those who think only in terms of the short term, do not see the long-term picture. For South Africa to continue to import and export, we need new ports. Our ports are full. Meanwhile, our railway lines are bad or not well maintained, so they are using trucks to haul manganese and coal, so that messes up the roads. And we lose lives too.

Question: We had better railways in the early 20th Century than we have now. We need to look at this worldwide, and we need to do what Roosevelt wanted to do, which is to decolonize Africa and all the other colonies, and go with the most advanced technologies, like maglev trains. . . .

The South African rand is one of the most traded currencies of developing countries, and you have to be very careful with your policies, statements, fiscal policies, because things happen fast, and it does constrain you. Because if an analyst somewhere doesn't like what you're doing, then your currency goes. We are vulnerable. I'm not an economist, so I don't understand. . . .

Question: But you do understand that you need a science driver. and that you need to produce real things—you need a physical economy, and not a paper economy.

What a lot of people don't appreciate, is that it's a chicken and egg situation with infrastructure. You need to put the infrastructure there before industry will develop. You can't say to industry, "If you build an aluminum smelter, we'll build you a port." They are not interested. Take, for example, the Coega harbour project near Port Elizabeth on our east coast, which I was involved with on the IDC. "If you build a zinc plant there," we said, "we'll build a port." And the industry said, "No, no, no, show us you're going to build the port first." So, what happened? The zinc plant was cancelled.

And today there is a port, and now everybody's saying "It's a white elephant, it's not used." But Richards Bay is a port that was built 40 years ago. And people were saying then, "It's crazy, there's nothing there." But today it's the busiest port in the Southern Hemisphere.

Question: You need to have vision. You need to think 50 years ahead.

And energy is even longer. For a nuclear plant, you have to look ahead 60 or 80 years. So if we look back, to 1928, you had to make a decision on the nuclear stations we need now! If you make an investment decision, it's a long, long time you're talking about. If you make a wrong decision—that's where we are now. And I'm concerned that because of the cost issues with nuclear, that we're going to continue with coal. And we're going to get sanctions against us. Whether it's right or wrong, that's the reality. It's again one of those things that developed economies will say, "Look what I'm doing for carbon emissions and reduction.

Who's Trying to Strangle the PBMR?

by Gregory Murphy

The American Society of Mechanical Engineers held a conference in Washington, D.C., this Fall to highlight current research on high-temperature gas-cooled nuclear reactors.[1] These are the new generation of supersafe nuclear reactors using tiny fuel particles which each carry its own containment structure.

The Sept. 29-Oct. 1 conference focussed on the positive benefits of nuclear power, and in particular the many advantages for industry and agriculture from the high-temperature process heat that can be produced by these new generation reactors, which include both the pebble bed design, PBMR, and the General Atomics prismatic design, GT-MHR.

This focus was driven home with real optimism by the Vice Chairman of General Atomics, Linden Blue, in his keynote address. Blue said that the high-temperature gas-cooled reactor's "time has come"; the new reactor will revolutionize the nuclear industry and all other industries as well.

Behind the attacks on the PBMR are funds from George Soros (top right) and the Heinrich Böll Foundation (the foundation of the Green Party), and the hired pen of Greenwich University's Steve Thomas (top left). Above, green terrorists in the 1980s attacking a German nuclear plant.

It was a welcome change compared with the current small and narrow thinking of the nuclear industry, which attempts to sell the nuclear renaissance as the best solution to the non-problem of global warming.

The optimism that Linden Blue brought to his keynote carried over throughout the conference, as evidenced in the animated discussions after the conference presentations, in the hallways and the exhibit center (where nuclear companies have display booths). There has been a shift among some of the people in the nuclear industry, away from the "kicked dog" mentality of the past, to a fresh sense of hope, as was shown by the normally reserved German nuclear vendors. They were expressing true happiness at the prospect of Germany returning to a pro-nuclear power stance, as in the past, which they expect to happen some time after the next election.

The Soros/Thomas Factor

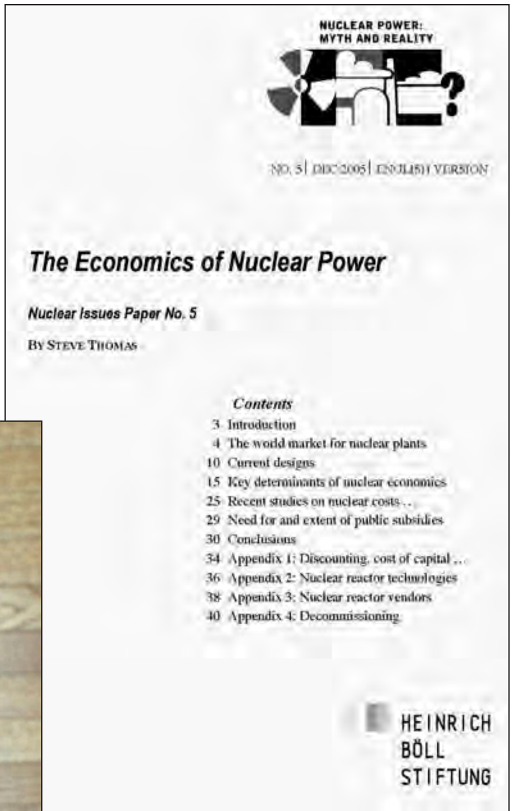
Haunting the 2008 conference was the specter of the latest attack on the South African PBMR, part of a negative campaign which has been going on for the past decade. The current attack was launched by a Soros-linked so-called "professor of energy policy" at Britain's Greenwich University, Stephen Thomas. In July 2008, Thomas wrote a white paper titled, "Safety Issues with the South African Pebble Bed Modular Reactor: When Were the Issues Apparent?" in which he cites a July 2008 report from Dr. Rainer Moormann of the Jülich Research Center. Jülich is the site of the first pebble bed test reactor on which the current design is based.

Moormann's report, titled "A Safety Re-Evaluation of the AVR Pebble Bed Reactor Operation and Its Consequences for Future HTR Concepts," was played up by Thomas as a major work of evaluation from the famed Jülich Research Center, which built and operated the AVR pebble bed reactor. In reality, as the conference discussion made clear, the report originated from one disgruntled employee of the institution, Rainer Moormann, who describes himself as a "risk assessment" guy.

In a discussion with this reporter, Thomas gave arguments against the South African PBMR which seemed to be little more

1. The 4th International Topical Meeting on High Temperature Reactor Technology ("HTR 2008: Beyond the Grid").

The decade-long attack by George Soros on the PBMR has been fronted by green fascist and so-called Professor of Energy Policy, Steve Thomas, of the University of Greenwich's School of Business. In July, Thomas sent his recent white paper, titled, "Safety issues with the South African Pebble Bed Modular Reactor: When Were the Issues Apparent?" to anti-nuclear groups and the European and South African media.



NUCLEAR POWER: MYTH AND REALITY

NO. 5 | DEC 2005 | ENGLISH VERSION

The Economics of Nuclear Power

Nuclear Issues Paper No. 5

BY STEVE THOMAS

Contents

HEINRICH BÖLL STIFTUNG

"No probative value," was the verdict of a South African court on one of Steve Thomas's reports on nuclear energy. Here, the title page from his December 2005 report.

University of Greenwich Public Services International Research Unit

than a thinly disguised racism of the British imperial type. Asked to explain why he opposed the pebble bed reactor, Thomas argued first: Why does South Africa believe that it could operate a high-temperature reactor, given the fact that the major nuclear powers have given up on operating them? (Doesn't Thomas know that it was a South African who did the first-ever heart transplant? Or that Japan and China are both operating demonstration HTRs?)

Thomas continued by saying that the pebble bed and other high temperature reactors have not been proven to be economical. Even if they were, he said, countries around the world would not buy them from a new or novel vendor like the South African PBMR, Ltd., because countries tend to be very conservative and usually go with known vendors.

Is Thomas really saying that because South Africa is a black nation, no one will trust them?

This attack by Thomas is not his first. Back in 2005, Thomas was hired to pen a report attacking the pebble bed for the Soros-funded Legal Resource Center in South Africa. Thomas's report was a key part of the case against PBMR in the legal challenge against the environmental impact study.

The legal challenge was joined by Earth Life Africa, a group set up in the 1980s to be the South African Greenpeace, which attached itself to the anti-apartheid movement to gain support and legitimacy. Earth Life Africa runs a large anti-nuclear campaign, called "Nuclear Power Costs the Earth." This is funded by the Heinrich Böll Foundation in South Africa and the Wallace Global Fund.[2] After the presiding judge read Thomas's report, he ruled that the environmental impact study had to be redone. This has caused PBMR undue delays in building the demonstration plant that was set to begin construction in 2004.[3]

When Thomas was asked by this author why he objected to the South African government being the largest stakeholder in the PBMR, Ltd. project, he said that it was because "public money" was being used on a project that has not gotten off the ground, and there are other uses for that same public money, like "health care and water projects." Of course, Thomas doesn't mention that his "reports" are the reason for the delay in building the pebble bed.

Privatization and Transparency?

Let's now look at where Thomas works: His office is in London, at the University of Greenwich's Public Services International Research Unit. This outfit is funded by Public Services International, a confederation of international trade unions, which includes, in the United States, Andy Stern's Service Employees International (SEIU) and the Teamsters. Yet, Public Services International is a grouping of rabid privatizers. According to its website, the group was very active in the former Soviet bloc during the "shock therapy" era of Jeffery Sachs and George Soros's Open Society Foundation.

Every year, the Public Services International Research Unit releases a resistance-to-privatization index, similar to the corruption index of that nation-state destroyer, Transparency International. With this background, it is laughable for Thomas to claim that public money is being misspent on the pebble bed, and not

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2. The Böll Foundation is Germany's premier greenie funder.

The Wallace Global Fund is part of the Wallace Genetic Fund that was set up by FDR's Vice President Henry Wallace in 1959. When first established, its mission was to further the legacy of Henry Wallace by helping to develop the world and increase the food supply. But current operations of the Wallace Fund really spit on Wallace's legacy by funding groups that attack modern agriculture and the development of nuclear power, and promote depopulation of the world.

3. For further details on this story, see Dean Andromidas, "Who's Sabotaging the PBMR?" *21st Century Science & Technology*, Spring-Summer 2006.

Stuart Lewis/EIRNS

Mega-speculator George Soros funds the South African environmentalist groups to further the aims of the British in splintering the continent and cutting its population.

given to health care and water projects, which he and his grouping are looking to steal.

The South African *Cape Times* newspaper picked up Thomas's white paper and promoted its deceptions. *Cape Times* green correspondent Melanie Gosling wrote an article titled "New PBMR Will Fail U.S. Standards," which argued, entirely falsely, that the PBMR would not be certified by the U.S. Nuclear Regulatory Commission because it does not include a secondary containment structure in its design. In fact, the self-containing design of the multilayered fuel particles and the reactor characteristics render a secondary containment structure unnecessary for this type of reactor.

Second, Gosling's claim that the PBMR does not meet U.S. safety standards is entirely bogus. The Nuclear Regulatory Commission has not been formally given the request for a design license by PBMR, and currently the NRC is working in close cooperation with the South African nuclear regulatory group to work out what the safety regulations will be.

The argument for secondary containment was the main alarmist point in the Moormann report, and was also played up by Steve Thomas in his white paper. Sources from PBMR Ltd. whom I questioned at the recent conference, said that they had replied to e-mail questions from Ms. Gosling, but that none of their responses was used, even in part. Gosling's question shows that she doesn't understand the principles behind the pebble bed. Moormann, who understands the basic principle, still maintains that a gas-tight containment is needed for pebble bed reactors. How was this rebutted?

This is what the PBMR spokesmen wrote:

> While containment is an appropriate concept for reactors which use water as a coolant, we believe the best concept for gas-cooled reactors such as the PBMR is to filter the helium (i.e. remove the radioactivity). The radioactivity will therefore be contained, not the coolant. . . . The PBMR confinement concept is by no means inferior to that of a containment structure. It is our view that confinement is the best solution for a gas-cooled reactor, both from a technical and safety point of view. Analyses have shown that confinement will reduce—rather than increase—the risk of radiation releases to the public. It is therefore a safer concept. The PBMR confinement concept allows for the release of extremely well-filtered coolant (helium).

PBMR, Ltd. knew that the specter of the Moormann controvery could have cast a pall over the conference, and their scientists and engineers came prepared to intervene with a prepared safety briefing, both in printed and CD format. PBMR also produced a CD of their presentations countering the Moormann report, which was distributed to the conference.

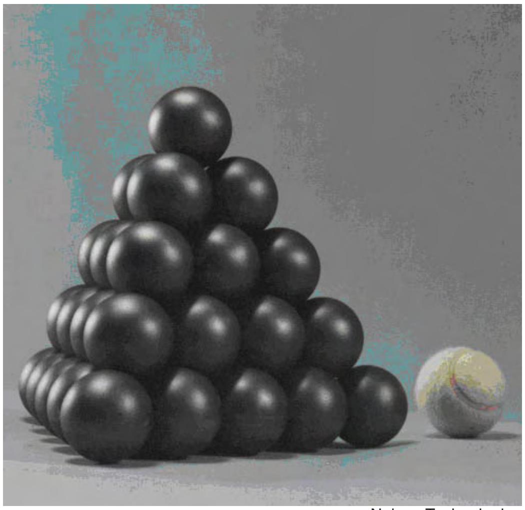
What's Wrong with Moormann's Argument?

Let us now take a look at the source report for Thomas's latest attack, the report by Rainer Moormann. When his paper was issued in July of this year, there was an immediate uproar in the high-temperature reactor community working at the Jülich Research Center, including many internal e-mails attacking the report. In fact, the report is one person's opinion on the data that were accumulated from the 21 years of successful operation of the AVR reactor in Jülich, Germany.

Moormann describes himself as a risk assessment person, and his report shows him to be a person devoted to the precautionary principle: Everything must be shown to be without risk in order for a program or new technology to be brought into use. Moormann's report, however, is based on the 40-year-old design of the AVR. The main concerns he raises are the release of the radioactive isotopes strontium-90 and cesium-137 into the primary coolant loop. Moormann claims in his report that this was caused by the unusually high temperatures at which the AVR core operated. Based on this assumption of these unusually high temperatures, Moormann states that the ability to produce high-temperature process heat, which is a main advantage of the pebble bed, should not have been demonstrated.

Moormann's report is *not* anti-nuclear, as Thomas and the Greens in the media have presented it. His report contains some conclusions that are worth looking at in designing future high-temperature reactors. But his main conclusion, that the pebble bed reactor needs an airtight containment, is just pure alarmism and shows a real failure in his interpretation of the lessons learned at the AVR.

It is to their credit that the organizers of the HTR 2008 confer-



Nukem Technologies

Sample fuel pebbles for the PBMR. Each fuel sphere contains about 15,000 fission fuel kernels. About 450,000 of these pebbles will be loaded into each reactor vessel.

Nukem Technologies

Fuel spheres in production at Nukem Technologies. After the fuel particles are pressed into the core of the fuel spheres, a layer of graphite material is added and the sphere is machined and then carbonized and annealed at 2,000°C. The spheres then go though several quality control tests, including X-rays to check the centricity of the fuel core.

ence invited Dr. Moormann to present his paper there in person, and face his peers. This was the first time, in fact, that this author has seen a real discussion on a controversial paper like Moormann's at a conference. Most often, the author, if invited, gives such a presentation and leaves. To his credit, Moormann took several questions after his presentation and stayed around to discuss his paper with attendees and answer some tough questions about his conclusions.

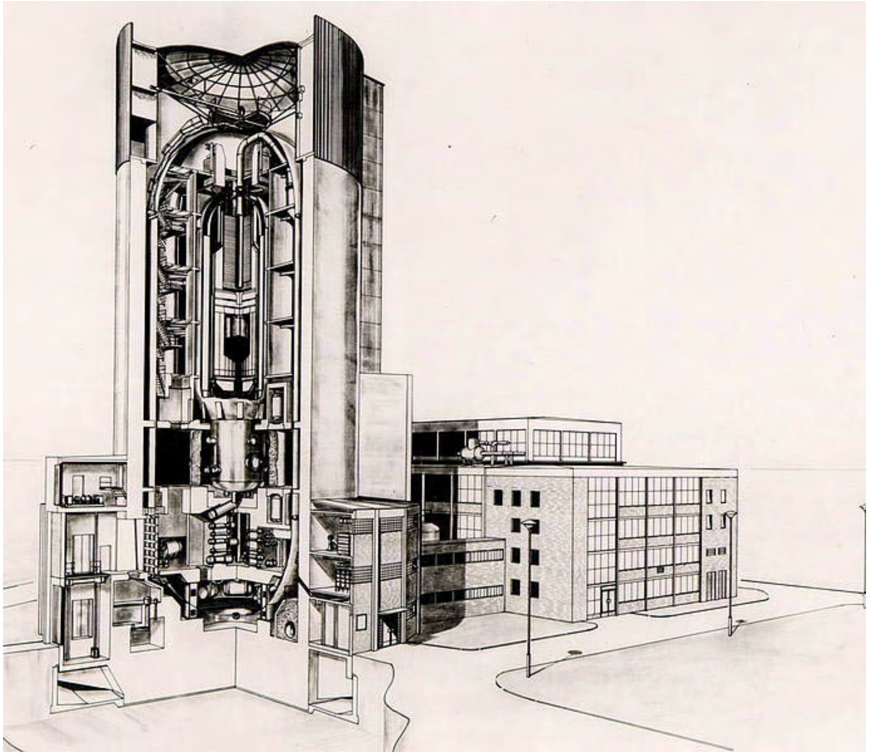
It was exciting to see a real fight about ideas taking place in a nuclear conference, where usually conference attendees just complain and get enraged, but never confront the issue. It is also a good sign for the nuclear industry to show that it is not afraid to confront controversial reports—something the industry has failed to do in the past 30 years.

As part of the general discussion of issues in the Moormann report, there were several other presentations on the data from the experimental AVR. Most of them showed that the majority of the strontium-90 releases happened in the early years of the reactor operation, when poor quality fuel was introduced into the core, and stayed in the core for longer time periods. But, as noted in a presentation by Karl Verfondern, et al. from the Jülich Research Center, titled "Fuel and Fission Products in the Jülich AVR Pebble Bed Reactor," the early fuel was of poor quality and used highly enriched uranium, which was the source of the release of strontium.

Nukem Technologies

The first core loading of the Thorium High Temperature Reactor in Germany, which was constructed in 1983. Both the THTR and the AVR were shut down in 1988 as part of the political reaction in Germany that followed the Chernobyl accident.

In his presentation, Dr. Vernfondern shows that as a better quality of fuel was introduced into the core of the AVR in the mid-1970s, the release of strontium and cesium went down. Most of the strontium activity monitored came from the earlier fuel, as could be demonstated from the 30-year half-life for strontium-90.



Arbeitsgemeinschaft Versuchsreaktor GmbH

Cutaway view of the AVR experimental high-temperature reactor at Jülich, Germany. This was the first HTR to use a pebble bed core, and it operated successfully for more than 20 years, from 1966 to 1988. The AVR demonstrated the high-temperature capability and its safety features, including a safe shutdown with total loss of coolant and no control rods.

Arbeitsgemeinschaft Versuchsreaktor GmbH

Dr. Rudolf Schulten (left) developed the pebble bed concept and built the first prototype, the AVR at Jülich, Germany. Here he is consulting with Dr. Werner Cautius in the AVR control room.

The best rebuttal of Moormann's report came from the scientists and engineers who work with the PBMR. It was masterful in that it judoed the report by showing that, using the exact same AVR data set which Moormann used, their "Dust and Activity Migration and Distribution (DAMD) model" demonstrated (as did most of the other studies) that it was the poor quality of fuel in the beginning of operations of the AVR which was largely responsible for the problem. They also showed that certain core design problems, since recognized, created voids and bypasses in the coolant flows around the pebbles.

One has to remember that the Jülich AVR was a first-of-a-kind reactor; it was the first pebble bed reactor ever built, and operated for 21 years with only minor incidents. In those 21 years of operation, the AVR generated a very valuable data base and there were many engineering lessons learned, which have already had their impact on future design specifications.

One recent development is that with the use of high-temperature fiber optics, it may be possible to monitor the core temperatures of pebble bed reactors. Because of its moving fuel—with pebbles introduced at the top, flowing through, and reintroduced at the top again—it is difficult to precisely monitor the internal temperatures. But that may be solved with the application of engineering principles and some human creativity, the real answer to any design problem.

AVR: A Pebble Bed Success Story

I have discussed the criticisms of the AVR reactor in the Moormann report, and the unscrupulous use of this report by Steve Thomas to attack the South African pebble bed reactor program, which holds such promise for developing Africa. Now let's look at what a success story the AVR and its sister pebble bed reactor, the THTR, really were.

In 1959, the agreement on the construction of a pebble-bed reactor was signed by BBC/Krupp and Arbeitsgemeinschaft Versuchsreaktor GmbH (AVR Experimental Reactor Group). Construction of the AVR, a 15-megawatt-electric demonstration reactor was the first high-temperature reactor to use a pebble bed core, as developed by scientist Rudolf Schulten, the director of the Jülich Nuclear Research Center.

Construction began in 1961, and the AVR went critical in 1966. A year later, the AVR was supplying electricity to the grid. The AVR was originally designed to breed uranium-233 from thorium-232. Thorium-232 is about 400 times as abundant in the Earth's crust as the fissionable uranium-235, and an effective thorium breeder reactor would be considered valuable technology. However, the fuel design of the AVR contained the fuel so well that the transmuted fuels were uneconomical to extract at the time. As a result, the AVR became a test-bed for different formulations of reactor fuel with different coatings. During the 21 years that the AVR operated successfully, 18 different types of pebble fuel were tested. Until the AVR was shut down in 1988, new types of fuel pebbles were loaded into the core.

The AVR tested the pebble bed's main safety features. In one test, during the 1980s, the AVR reactor was brought to full power and the coolant flow was stopped, to demonstrate a loss-of-coolant accident. It was found that one of the main design safety features, the negative coefficient of reactivity (as the reactor fuel gets hotter, it becomes less reactive), responded beautifully as planned. With all coolant lost, the reactor temperature increased but the reactor shut itself down.

General Atomics

The 300-megawatt THTR was unique, having a pressure vessel made of prestressed concrete, instead of the usual steel.

After the operating success of the AVR, another, larger HTR was was constructed in 1983, the Thorium High-Temperature Reactor, THTR-300. Like the AVR, the THTR had a pebble bed design core. The core contained about 670,000 spherical fuel balls, each 6 centimeters in diameter. This reactor was unique, in that the pressure vessel that housed the pebble bed was formed of pre-stressed concrete—the first time this material had been used instead of a steel pressure vessel.

The THTR operated successfully for five years, with only a minor water ingress accident, where water from a burst tube in the steam generator leaked into the reactor core. Nevertheless, both the AVR and the THTR were shut down in 1988, because of the anti-nuclear hysteria that surrounded the aftermath of the Chernobyl reactor accident in April of 1986.

The Beauty of Modular HTRs

High-temperature reactors are the keystone to development because they are modular, and can be built in remote areas like rural areas in India or small city areas in Africa. These reactors can provide electricity and at the same time, provide high-temperature process heat for water desalination where needed, or for producing hydrogen. The fact that these reactors are modular, means that they could be built on site of industrial companies, for example, petrochemical plants, to provide high-temperature process heat to make better plastics. This would be a great benefit to industry, which right now burns large amounts of natural gas just to produce the needed process heat.

All of the possible uses of the pebble bed or the General Atomics prismatic block HTRs are limited only by man's imagination!

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Space Exploration Momentum Moves East

by Marsha Freeman

China's stunning 14-minute spacewalk during the three-man Shenzhou VII mission in September, shown live worldwide on television, symbolizes the shift in focus of space exploration from the United States, Russia, Europe, and Japan, to the new space nations of China, India, and South Korea.

Commentators who try to denigrate Chinese space accomplishments say that what China is doing in manned spaceflight, the United States already did in the 1960s. But in an important way, that is precisely the point. Today in China, the strides being made in space have captured the imagination of a generation of young people and increased interest among students in studying science and engineering. Space missions have led to the building of new science museums, increased national pride, and optimism about the future.

A look at what China is doing recalls the U.S. excitement around space during the 1960s Apollo program years. In early November, a full-scale model of the Shenzhou VII spacecraft was displayed at the 7th China International Aviation and Aerospace Exhibition in Zhuhai, Guangdong Province. As shown on Chinese television, visitors—young and old—eagerly climbed inside the model of the module, to see what it was like to be an astronaut.

Then, on Nov. 7, in the Great Hall of the People in Beijing, Chinese President Hu Jintao and Premier Wen Jiabao honored the Shenzhou VII crew. They described the mission as a "moment of joy and pride for the astronauts . . . and those who have contributed to China's historical space-walk mission." With obvious reference to Neil Armstrong's history-making step onto the lunar surface nearly 40 years ago, spacewalk astronaut Zhai Zhingang proudly described his accomplishment as "the first time that a Chinese national left his footprint in space."

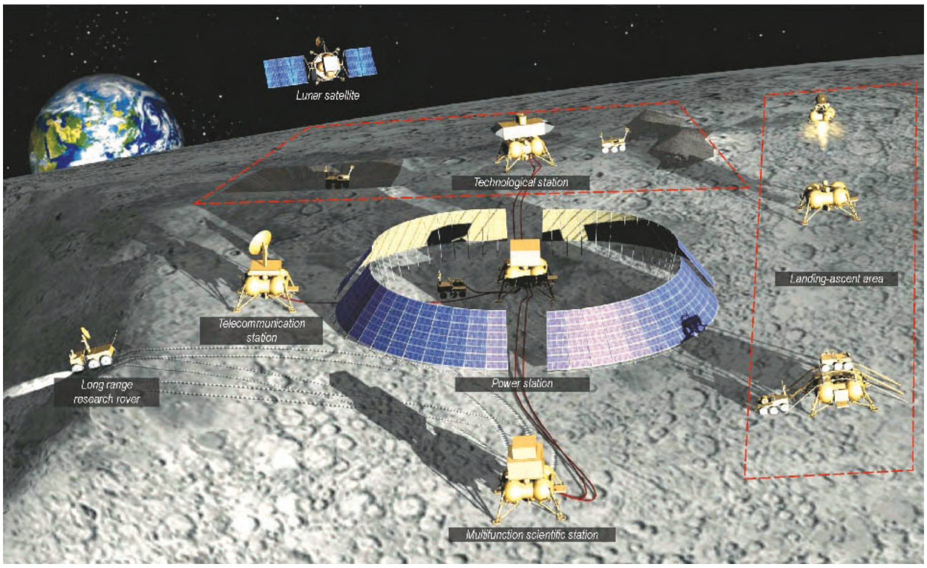
During a post-flight visit to Hong Kong, the three Shenzhou VII astronauts talked with students at a public forum, and opened an exhibition about their mission. The success of the brief space walk during the Shenzhou VII mission has prepared China's space program for the next goal—the docking and rendezvous of spacecraft in orbit, and the deployment of a small space station.

Inset: a videograb of a Shenzhou astronaut live in space.

China is just one of the new Asian nations exploring space. India has under way its first deep-space mission to the Moon, Chandrayaan-1. South Korea is also becoming a space power, having sent its first astronaut scientist aboard a Russian Soyuz last April, to spend 11 days on the International Space Station.

Waking up the 'Old Men' of Space

The Asian focus of space momentum, enthusiasm, and optimism was striking in the presentations at this year's International Astronautical Congress in Glasgow, Scotland, Sept. 29-Oct. 3, which gathered more than 1,000 scientists, engineers, and space policy makers and planners. It was also clear that the impressive accomplishments and ambitious plans of the Asian space powers has goaded the "old men" of space to take a fresh look at



Lavochkin Association/Roskosmos

Russia is planning a three-phase lunar program, which culminates in a manned base. To prepare for men on the Moon, infrastructure will be placed on the lunar surface, including launch and landing areas, a power generating station, scientific platforms, communications links, and rovers, as seen in this artist's rendition.

their own plans.

Russia, the United States, Japan, and Europe are now under pressure to do more from the "young" and emerging space powers in Asia. This has resulted in long-overdue reassesements of future space plans.

Western Europe and Japan bowed out of developing manned launch capabilities in the 1990s, although they already had decades of experience in developing space technology. The European Space Agency is now considering either partnering with Russia on a next-generation manned space vehicle, or man-rating its own Ariane 5 rocket and developing a manned version of the Automated Transfer Vehicle, sent to the International Space Station earlier this year. In the 1990s, Europe stopped development of both the German Sanger spaceplane and the French Hermes design.

Like Europe, Japan has flown astronauts on Russian and American spacecraft, and has built a laboratory for the International Space Station, but in the 1990s, it halted development of its Hope spaceplane. Recently, with China flying taikonauts in space, India joining in deep-space lunar exploration, and South Korea soon to become a space power, Japan, like Europe, has been shamed into trying to regain some momentum.

In March 2005, the Japan Aerospace Exploration Agency released its "JAXA Vision 2025" document. Included for the first time, is the goal to "establish the capability ... to transport goods and humans easily to outer space." The Vision document sees Japan's human space endeavor as closely tied to the future utilization and exploitation of the resources on the Moon.

Russia, which saw its civilian space program nearly destroyed during the pre-Putin "IMF years" of economic jihad, is now attempting to rebuild its space design, engineering, and manufacturing infrastructure. It plans to accelerate this effort by embarking on new projects with the help of international partners, including those from Asia.

But as nervously noted by speakers at the Congress, the world is in the midst of an existential financial and economic crisis. Carrying out the ambitious space exploration missions that are planned, will require new international policies, and a new financial architecture based on investments, not in speculation, toxic waste, and bank bailouts, but infrastructure, science, and new technology.

Building Space Infrastructure

China is not interested in any "flash-in-the pan" space spectaculars, no matter how many commentators say that China is in a "space race." This is evidenced by its multi-decade plans for developing and deploying the full range of infrastructure needed for manned, scientific, planetary, and Earth applications missions, just as the United States has done.

The Shenzhou VII mission tested such new infrastructure. The nerve center of China's space program, the Beijing Aerospace Control Center, for the first time, controlled more than one mission in real time. While keeping track of, and communicating with, the three Shenzhou VII crew members, the Center was also tracking China's Chang'e lunar orbiter. More than half of the technicians working at the Center are under the age of 30, the director, Zhu Mincai, told *Xinhua*.

In order to launch any spacecraft heavier than the current first-generation Shenzhou model, China must develop larger launch vehicles. This is under way. A year ago, China announced that a new series, the Long March 5 rocket, was under development. The rocket, able to carry 25 tons of payload into Earth orbit, will be used to send lunar rovers, large satellites, and stations into space. It will be ready in 2014.

A year ago, China also announced that a fourth rocket launch center would be built on the southern island of Hainan, to be completed in 2012. It will accommodate the larger versions of the Long March rockets. From this southern latitude, China will be able to launch larger spacecraft more efficiently. According to *People's Daily*, the site will include a "space manor," as an auxiliary facility, to house the breeding of mutated seeds that have been in space. And, for the first time, there will also be a visitors' center.

In the early days of Soviet and American manned space flights, communication with crewmen was only possible when a spacecraft was directly over a ground- or sea-based station. During the Space Shuttle program, the U.S. launched as series of Tracking and Data Relay Satellites, to allow nearly uninterrupted communications between the ground and the Shuttle crew. In April, China launched its first geosynchronous relay satellite, Tianlian 1, to improve orbit-to-ground communications. This has increased mission control's contact with

China's astronauts from 12 percent to 50 percent of each orbit.

China has launched a range of Earth-orbiting satellites, for remote sensing, communications, science, and technology development. On Oct. 25, and again on Nov. 5, 2008, research satellites went into orbit, in quick succession. The small Chuangxin 1-02, developed by the Academy of Sciences, will collect and relay hydrological and meteorological data, and be used in disaster relief. The Shiyan Satellite 3, developed by the Harbin Institute of Technology, will test technologies for exploring the atmosphere.

China has in the works a system of navigation satellites, similar to the American Global Positioning System and Russia's Glonass constellation, which it expects to be operational and cover all of Asia, by 2010. The Compass/Beidou system will be compatible with the GPS and Glonass systems, and will have 5 geosynchronous satellites and 30 in a lower-Earth orbit.

The same multi-decade approach that China is using in its Earth-orbital missions (unmanned and manned), is seen in its multi-phase lunar exploration program. At the International Astronautical Congress in Glasgow, for the first time, Chinese scientists released data that have been collected over the past year by its Chang'e lunar orbiter.[1] Although NASA has initiated an International Lunar Network effort for lunar-exploring nations to coordinate their robotic exploration of the Moon and divide up responsibilites for new spacecraft, China is not included. This exclusion has encouraged China to proceed with its own effort, while seeking bilateral cooperation with other nations.

According to the top officials and scientists in its lunar program, China's next step in its three-phase program will be the launch of Chang'e-2. During the early November International Aviation and Aerospace Exhibition in Zhuhai, Yan Zhongwen, from the Academy of Sciences, explained that this second lunar mission would deploy two landers, carrying two rovers, which would be placed at different places on the Moon, "to get a more complete picture of its surface." At that exhibition, visitors watched a model of the rover unfold its solar panels and move around the simulated lunar surface.

At the Glasgow Congress, China National Space Administration (CNSA) head, Sun Laiyan, reported that the next Shenzhou missions will demonstrate the ability to have two spacecraft rendezvous and dock, a prerequisite for assembling a space station in orbit. A small laboratory, he said, is planned for 2011.

On Nov. 12, the Chinese State Administration of Science, Technology, and Industry for National Defense, which oversees the lunar program, unveiled the first full map of the Moon that was created from photographs taken by Chang'e-1 over the past year. Experts described it as the most complete map, and the richest in detail. It was also announced that Chang'e-2 would be launched before the

Shenzhou VII: China's First Space Walk

Coming just two days after the successful completion of a stunning 14-minute spacewalk carried out during the three-man Shenzhou VII mission, the opening of the International Astronautical Congress in Glasgow began with congratulations to China on this accomplishment. A clamor for more details about the Shenzhou VII mission led to the last-minute scheduling of a "late-breaking news" session, Oct.2, presented to a packed auditorium.

Dr. Li Ming, board member of the Chinese Society of Astronautics, explained to the audience that China's interest in manned spaceflight went back to the 1960s. But the studies done in the 1960s, he said, were cancelled in the next decade. Then, starting in the 1990s, he said, the "technology has developed very rapidly."

While showing spectacular film footage of the Shenzhou VII mission, Dr. Li reported that two hours after China's first-ever space walk, a small, less-than 80-pound accompanying satellite, developed by the Chinese Academy of Sciences, was released from the main craft. Subsequent articles describing the mission have noted that this BX-1 subsatellite orbited near the Shenzhou, taking more than 1,000 close-up photographs. After the astronuats had returned to Earth, the BX-1 subsatellite was commanded from mission control to circle the Shenzhou's orbital module, which stays in orbit empty, after the crew leaves.

Through this exercise, China demonstrated the ability to fly two spacecraft safely in close proximity; remotely maneuver a spacecraft, with a high degree of accuracy; and use the subsatellite to relay data from the orbital module to the ground.

Although Chinese space officials are not often specific about the next steps in their manned space program, it is generally agreed that China will orbit a small space lab next, known as Tiagong 1. It will receive visits and deliveries of equipment from at least two unmanned Shenzhou spacecraft.

After Tiagong 1 is in orbit, Shenzhou VIII, launched unmanned, will rendezvous and dock with the laboratory. It is possible multiple dockings and undockings will be carried out, for practice. Shenzhou IX would be the second, unmanned ship to dock with the lab, and Shenzhou X would be the next manned mission, delivering a crew to live and work in space.

Qi Faren, who designed the Shenzhou craft, told the *Shanghai Daily* in September that the three craft would be launched in quick succession, with intervals of less than a month between them. If all goes according to plan, the three flights should take place in the next two or three years. This first space lab would be manned for short periods of time, or man-tended, and used to master the complex skills needed for a later permanent manned presence in orbit.

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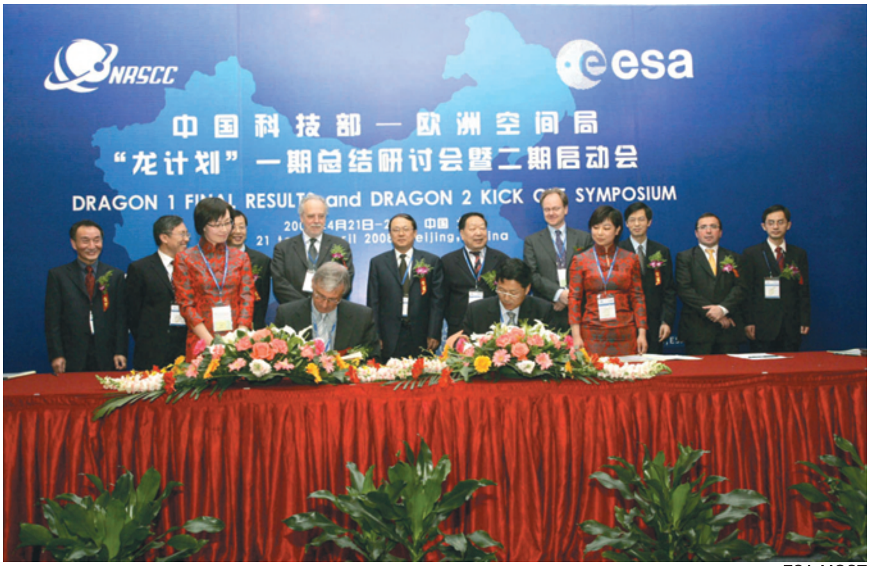
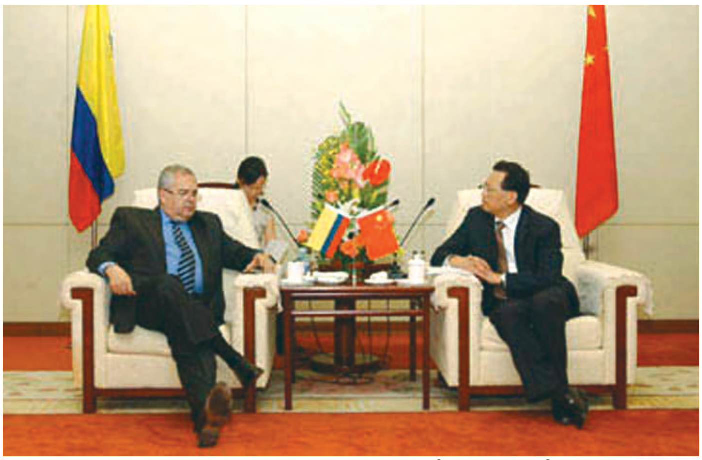
1 For details on the scientific goals of the Chinese, Indian, Russian, Japanese, and U.S. lunar missions, see, "Mankind Is Going Back To the Moon!" *21st Century*, Spring-Summer 2007.



ESA-MOST

As part of its international cooperation outreach, Zhang Guocheng, Director of China's National Remote Sensing Center (r), and Stefano Bruzzi, who heads the European Space Agengy's Earth Observation Program Planning and Cooperation Service, signed the protocol for Earth remote sensing cooperation in the Dragon 2 program, in April 2008.



China National Space Administration

Sun Laiyan, Administrator of China's National Space Administration (r), meeting June 4 in Beijing with Carlos den Hartog, Colombia's Ambassador to China. Sun expressed China's interest in cooperation in space technology, as part of its outreach to Ibero-America.

end of 2011, and involve testing five new core technologies, such as soft landings. After the presentation of the map, lunar chief scientist Ouyang Ziyuan called for scientists from Asia to work together, saying that China, India, and Japan have the same goals, and should step up cooperation to "deepen mankind's understanding of the Moon."

International Outreach

China has been able to reap economic rewards for its civilian sectors from its systematic and focussed developments in space exploration. This is something the Soviet Union was never able to master, although this approach led to decades of "spin-off" technologies and real growth, in the U.S. economy.

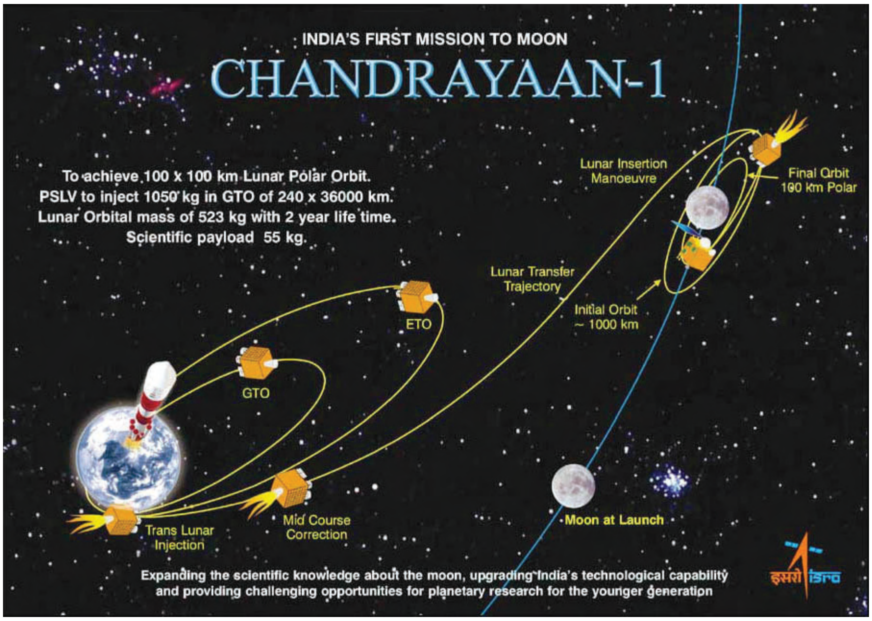
The day after the Shenzhou VII liftoff, *Xinhua* summarized some of the economic benefits. Data from the China Aerospace Science and Technology Corporation (CASC), show that of the more than 1,000 types of new materials China has developed in recent years, 80 percent were driven by the requirements of space technology. Nearly 2,000 items have been transferred from the space program to civilian economic agencies, and at the end of 2007, more than half of the revenue of CASC was from civilian sectors. Specific high-technology bases have been established to transfer space technology to industrial centers. "How much space technology can radiate to civil industries is unmeasurable," an economics professor at Beihang University told *Xinhua*.

To bring additional resources into its civilian space program, to increase its international prestige, and to broaden space cooperation, China has become a provider of satellite and launch technology to developing nations. On Oct. 30, China launched a communications satellite for Venezuela, its first for a nation in Latin America. The satellite, built in China, was monitored from a new control center in Venezuela, staffed by dozens of Chinese and Venezuelan technicians. The spacecraft, which will be used for communications, remote learning, and telemedicine, will have coverage from southern Mexico to Chile and Argentina, with services being offered to neighboring nations.

The satellite development included the participation of 90 specialists from Venezuela, who were trained at the Beijing University of Aeronautics and Astronautics, in a technology transfer program. Last June, the head of China's space agency met with the Colombian ambassador to China in Beijing to discuss space cooperation, and China has a longstanding joint space satellite research program with Brazil. In March, the new head of the Brazilian Space Agency, Carlos Ganem, stated at his inauguration ceremony, that Brazil would intensify its cooperation with China.

Not surprisingly, a major focus of China's international initiatives has been in Asia. It has worked on bilateral projects, such as a new agreement to develop a telecommunications satellite and ground station for Laos. Its regional project is the Asia-Pacific Space Cooperation Organization (APSCO), which was established by China, Thailand, and Pakistan in 1992. Since then, Mongolia, Iran, Peru, Bangladesh, Indonesia, and Turkey have joined, and Argentina, the Philippines, Malaysia, and Ukraine are considering membership. At the International Astronautical Congress in Glasgow, Chinese space head Sun Laiyan said China would include the training of foreign astronauts as part of APSCO's program.

Reflecting on the potential for China becoming a global space power, Russian



India Space Research Organization

When the Chandrayaan-1 spacecraft went into lunar orbit around the Moon on Nov. 8, India became the fifth nation to send a spacecraft to the Moon.

Academy of Cosmonautics corresponding member Andrei Ionon told *RIA Novosti* on Oct. 23: "Today we [Russia] must think about who our key partners in space exploration are. This may be the right moment to start looking eastward, rather than westward."

Russia and China have developed a close cooperative relationship in space development, since 1992. Russia has helped train Chinese astronauts, sold China spacecraft, spacesuits and other technology, and helped China carry out the successful space walk during the recent Shenzhou VII mission. Over the past eight years, Russia and China have signed nearly 100 specific contracts, under 10 cooperative agreements.

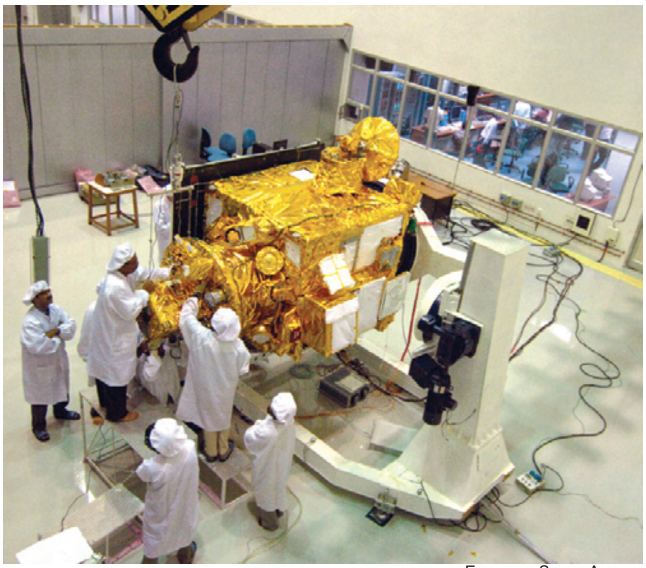
Next year, Russia plans to launch a mission to Mars's moon, called Phobos-Grunt (Grunt means soil). China was invited to provide a microsatellite to fly with the Russian Mars spacecraft, which it has named Yinghuo-1 (Firefly). The small Chinese satellite will be released from the Russian Phobos-Grunt ship, and will orbit Mars to study its atmosphere.

India's First Lunar Mission

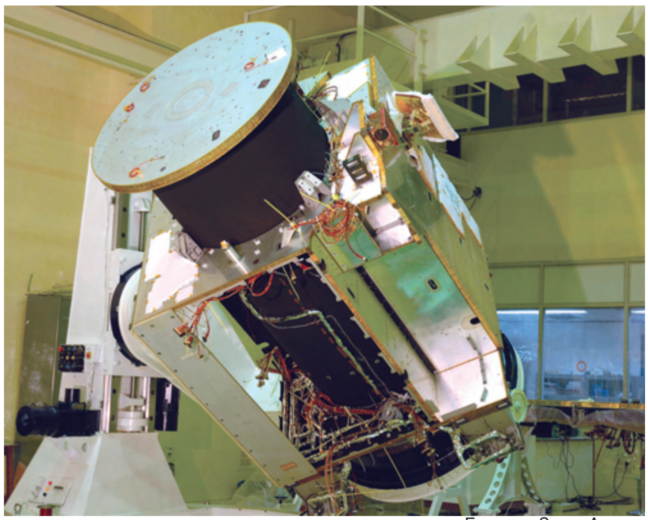
India has had an impressive space program for decades, but, until recently, it has focussed almost exclusively on the application of space technology for the economic development of the nation. These have included the extensive use of Earth-orbiting satellites for weather forecasting, telemedicine, distance learning, communications, and remote sensing.

Just days after the conclusion of the Astronautical Congress in Glasgow, on Oct. 22, the Chandrayaan-1 (Moon craft) spacecraft was sent on its mission to the Moon, launched on an uprated version of India's Polar Satellite Launch Vehicle. With help from NASA, through free access to its Deep Space Network, the Indian Space Research Organization, ISRO, is able to augment its limited space communications capability, enabling it to receive scientific data from Chandrayaan-1 around the clock. More than half of the scientific instruments aboard the spacecraft were contributed by foreign partners.

Also aboard the mother craft was a 64-pound impactor, which was released and


European Space Agency

Before the Chandrayaan-1 spacecraft was launched, it underwant a stringent series of ground tests, to decrease the risk of an unexpected failure during the mission.


European Space Agency

The Indian Chandrayaan-1 spacecraft during the integration of the scientific instruments and components with the main structure. The payload panels, where remote sensing instruments were to be mounted, are at right. The panel that holds the small impact probe is located at the top.

landed on the Moon. It relayed imagery and other data to the mother ship, which relayed it to Earth.

On November 8, ISRO announced that Chandrayaan-1 had successfully entered lunar orbit, after 11 days in flight. The final orbital-insertion maneuver made India the fifth country to send a spacecraft to the Moon.

India is now carrying out conceptual studies for its second lunar mission, dubbed Chandrayaan-2. The overall configuration of the mission has been finalized and the scientific instruments the spacecraft will carry will be chosen in the next few months. The project was approved by the Indian Cabinet on Sept. 18. Chandrayaan-2 will consist of both an orbit-

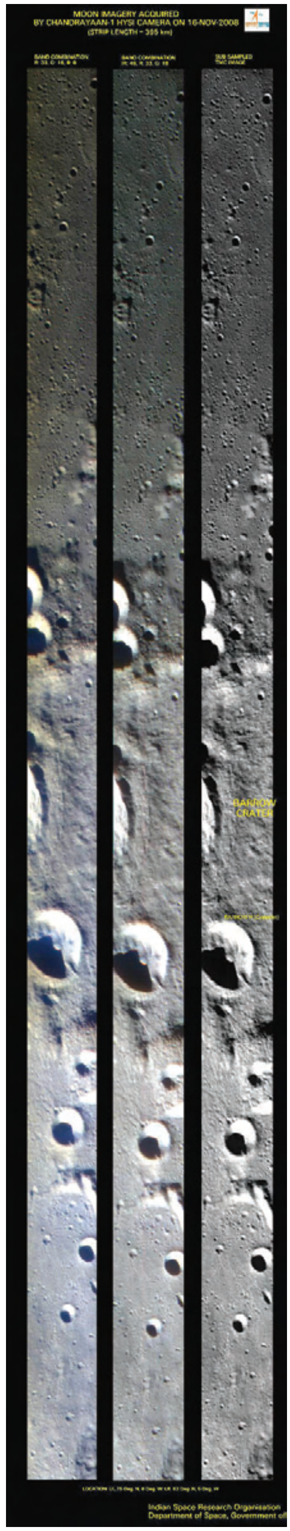
European Space Agency

◀ *(a) Technicians ready the 64-pound impactor that Chandrayaan-1 carried to the Moon. It was jettisoned from the mother craft on Nov. 14, and landed on the lunar surface, marked with the Indian flag.*

▼ *(b) Fully complete, and wrapped in protective gold foil, the impactor is hoisted to be mated with Chandrayaan-1.*

European Space Agency

(a)



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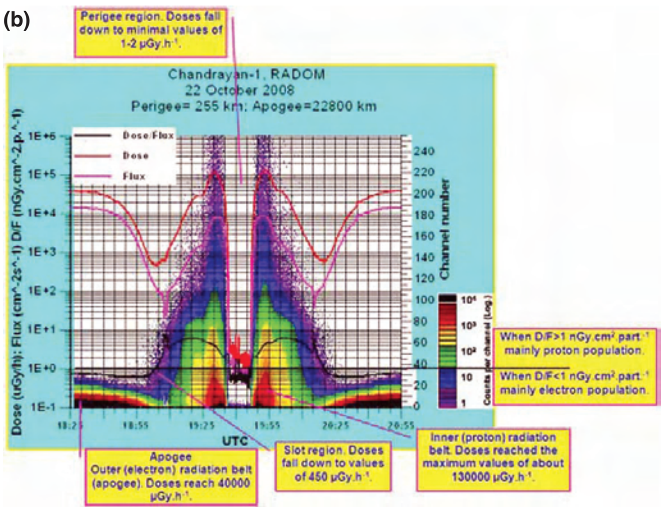


In mid-November, Chandrayaan-1 began taking photographs and collecting data about the Moon. High-resolution photographs (a) were taken in different wavelengths, to highlight various lunar features. The measurement of radon, a daughter of uranium which escapes from the lunar interior (b), will help scientists determine the history of the Moon.

Marsha Freeman

◀ *In April, Dr. Yi So-yeon became South Korea's first space-faring astronaut. She spent 10 days aboard the International Space Station, having arrived on a Russian Soyuz. At the International Astronautical Congress, Dr. Yi was part of a 50-person delegation from Korea. She is shown here in traditional dress, in a "Korea night" reception at the Congress.*

Korea Aerospace Research Institute

To fly on the Soyuz, Yi underwent survival training, as required for all Russian and guest cosmonauts who fly on Russian space vehicles. This includes preparation for an emergency landing at sea.

er and a lander. In November 2007, India and Russia agreed to carry out a joint mission, with Russia building the rover, which will have a robotic arm to collect samples and conduct *in situ* analysis of the soil. Other countries have been invited to participate, and NASA has expressed an interest in providing scientific instruments for the orbiter.

ISRO's Chandrayaan-1 program director, M. Annadurai, reported that for the follow-on mission, ISRO is considering a soft-landing technique, rather than a hard landing, because India "should be working on technologies that will be part of a proposed Moon base. If we are to become a developed country by 2020," he said, "it will be crucial for us to develop such technologies." Chandrayaan-2 is planned for launch in 2011-2012.

India is also planning to extend its exploration of space to Mars; an ambitious extension of the lunar mission. "The science which we plan to do on Mars has to have an international context," Chandrayaan-1 principal scientific investigator, J. N. Goswami, told the Astronautical Congress in 2007, at its meeting in Hyderabad, India. ISRO's Advisory Committee for Space, in its plan to the year 2020, has recommended a Mars orbiter, to be developed in the 2009-2017 timeframe.

ISRO chairman Nair announced Nov. 10 that, building on the success of Chandrayaan-1, India has approved its first mission to the Sun, which is to be a small probe, called Aditya. India's first astronomy satellite, Astrosat, will be launched in 2009, ISRO also reported, to study the X-ray emissions of stars, galactic nuclei, and the core of the Milky Way.

India is on the path to create a broad-ranging space exploration and science program.

A New Player: South Korea

Although its progress has not attracted too much international attention (with the Western press more interested in manufacturing a "space race" among China, India, and Japan), South Korea is becoming a new space power in Asia. Last April, Korea's first astronaut, scientist Yi So-yeon, went into space aboard a Russia Soyuz, and spent 11 days on the International Space Station. Her flight generated widespread excitement throughout the country. More than 36,000 Koreans had applied for the mission, which was the result of an agreement signed with Russia in 2005.

While he was visiting Russia's Baikonur Cosmodrome for Yi So-yeon's launch, Korean Air Force Chief of Staff, General Kim Eun-gi, said the Air Force will put forward a plan to recruit spacecraft pilots in the next 9 to 12 years. which Korea is discussing with the United States, China, and Russia.

South Korea plans to continue to develop its own space industry and skills, and is in the process of completing a launch facility, the Naro Space Center. It has previously designed and built its own satellites, but until now, they have been launched by other countries.

Also under development, is the two-stage Korea Space Launch Vehicle (KSLV). It is a cooperative venture, in which Russia is building the first stage, based on its new Angara rocket, and Korea is building the upper stage. The KSLV will be launched from the new Naro center. A successful launch would make South Korea the ninth country to launch a satellite from its own soil.

South Korea and the United States annnounced at a meeting in Seoul on Oct. 30, that the two countries signed a

Korea Aerospace Research Institute

Korea has developed an Imager (GOCI) instrument, which will be launched aboard the Communications Ocean and Meteorological Satellite, in June 2009. GOCI was developed in cooperation with France, and the remote sensing satellite will be launched from the European site in French Guiana. Here, an artist's depiction of the satellite.

statement of intent for future space cooperation. Discussions will include possible joint activities in space exploration, Earth science, planetary science, human space flight, and aeronautics. Korea has been especially interested in particpating in the NASA-initiated International Lunar Network (ILN), a multinational project to deploy the next-generation of lunar surface infrastructure. Korea signed a Statement of Intent to participate in the ILN, at NASA's Ames Research Center last July.

Kim Chang-woo, director General for Space Technology at the Ministry of Science and Technology, explained South Korea's intentions in a February article: "The Korean government recognizes space technology as a national strategic stepping-stone. When the Space Development Mid-Term Plan was established in 1996, the space development budget was 59.2 billion won. It was increased fivefold to 316.4 billion won in 2008." Currently there are more than 1,700 people were working in Korea's space sectors.

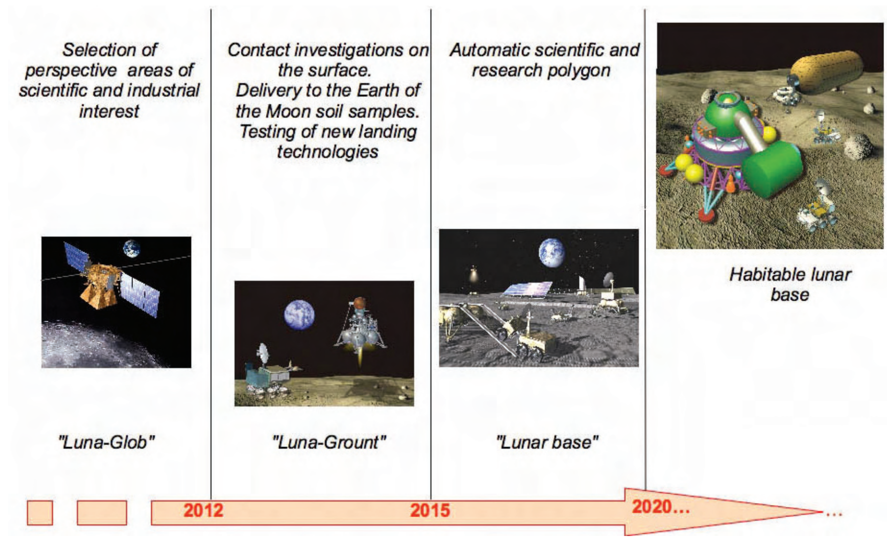
South Korea, Kim stated, has developed a Detailed Roadmap for Space Project Execution which includes the launch of a Lunar Orbiter in 2020, and a Lunar Lander, in 2025. He explained: "It will be difficult for us to launch a lunar satellite. . . . We are making progress towards further space development step by step. . . . We want to raise the dreams and hopes of the young generation for the space program."

The Korean government is well aware of the progress being made by its Asian neighbors, which increases international prestige in each case. But South Korea's space program also has a unique political aspect. Before her flight last April, Yi Soyeon said she hoped her flight would encourage closer ties between the divided Koreas, and help reconciliation. "I hope someday they will be one, and I hope the North Korean people will be happy with my flight," she said.

Russia: Rising from the Ashes

One of the great crimes of the international financial institutions, whose advice Russia foolishly followed after the 1989 fall of the Soviet Union, was draconian cuts in Federal spending in science, research and development, and in the space program. Russia's Buran reusable shuttle, and its Saturn-V-class heavy-lift rocket, the Energia, were mothballed. Funding was slashed for space science and planetary missions. Space design bureaus and manufacturing plants tried to hold on to their most precious resource—their people. As the director of Russia's Space Research Institute remarked earlier this year: "With the brain drain of the 1990s, we kind of lost a middle generation who could now transfer their experience to young specialists. It is almost like during the war. We have a kind of generation gap."

Russia is determined now to rebuild that capability, in a policy that comes directly from the top.



RUSSIAN MOON EXPLORATION ROADMAP

This roadmap for the next two decades of Russian lunar exploration missions was presented by Olga Zaytseva at the IAF Congress. The Luna-Glob orbiter will launch in 2011, followed by landers, rovers, the return of samples of soil, and the initial infrastructure for a manned, habitable lunar base.

Source: Russian Robotic Lunar Exploration Program, Dr. Gregory Poloschuk, et al., Lavochkin Association

Scientific tasks	Contact in-situ investigations in the near-Pole region of the Moon
Launch year	2012 (TBD)
SC composition	– lander – rover
SC mass	1200 kg
Rover mass	58 kg
Rover lifetime	1 year

'LUNA-GLOB/2' LANDING MISSION

The second Lunar-Glob mission, tentatively projected for the 2012 timeframe, would place a lander near a lunar pole, which would deploy a rover.

Source: Russian Robotic Lunar Exploration Program, Dr. Gregory Poloschuk, et al., Lavochkin Association

In line with former Russian President, and now Prime Minister, Vladimir Putin's stress on the rebuilding of industrial and scientific infrastructure, the Russian space agency Roskosmos announced in July that the agency's budget for 2009 would be double that of the previous year. In addition to funding for the manned program, support for Earth remote sensing and space science will increase.

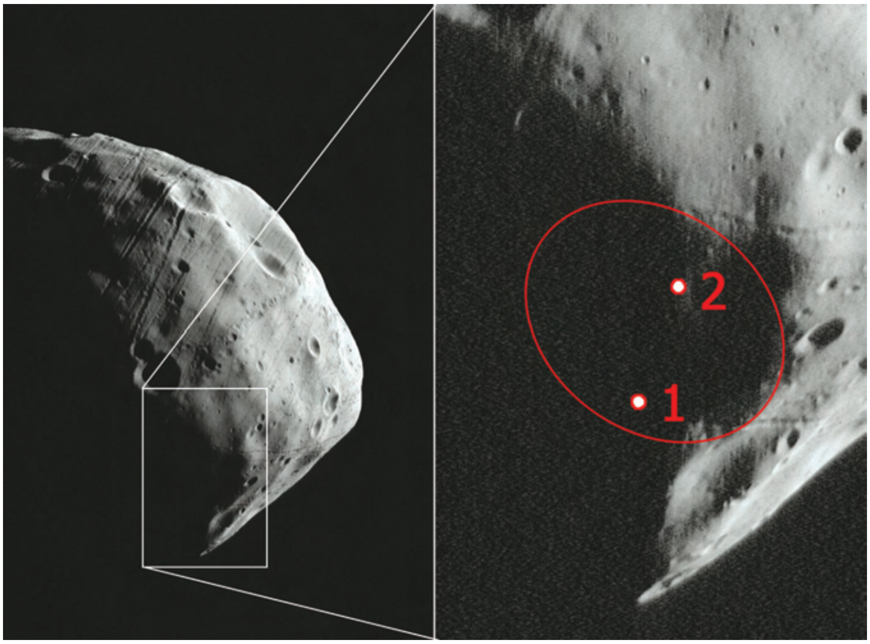
At a meeting on Oct. 21, Prime Minister Putin emphasized the importance of the Russian space industry for the development of the domestic economy. He cited examples where technological advances are being applied in the transport sector, agriculture, and manufacturing, but stressed that this has not been applied "on a systematic basis." He pledged that over the next three years, more than 200 billion rubles ($7.68 billion) would be allocated from the Federal budget for the space industry.

In addition to meeting its commitments to the International Space Station, a high-priority program is the construction of a new launch facility at the mothballed Svobodny military site, to be called Cosmodrome Vostochny (the name means Eastern). As part of the overall plan to refocus development on Russia's far east, new space infrastructure is being built, and the launch of the first rockets is scheduled for 2016. In 2018, Russia hopes to shift manned launches there, from Baikonur in Kazakhstan.

The workhorse of the Russian manned space program for the past 50 years—the Soyuz—will be replaced by a more modern version, and eventually, by an entirely new spacecraft. Russia is also now completing its navigational satellite constellation, Glonass, and will launch its first weather satellite, Meteor-M1.

Until recently, there have been mixed signals about what Russia is planning to do in space exploration. At the International Astronautical Congress, a concrete, and exciting perspective for Russian lunar and Mars exploration was put forward by government space representatives. As Alexander Medvedshikov, the deputy head of the Russian space agency, Roskosmos, said in Glasgow, the more expensive endeavors, such as manned landings on the Moon, will be pursued through international cooperation, at the same time that Russia is rebuilding its domestic infrastructure.

During a session at Glasgow on "Moon Exploration," Olga Zaitseva, deputy director for planetary exploration at the Lavochkin Design Bureau, which builds Russia's robotic spacecraft, outlined the upcoming Russian lunar missions. The first Lunar-Glob craft, scheduled to be launched in 2012, will send an orbiter to the Moon. This mission will also include a set of four small penetrators to study the subsurface of the Moon, which may



European Space Agency

The European Space Agency flew its Mars Express orbiter to within 60 miles of the moon's surface to take photographs, in order to help the Russian Space Agency find a suitable landing spot on Mars's tiny moon, Phobos. The inset at right shows potential landing regions and sites for Russia's Phobos-Grunt sample return mission.

be developed with Japan. Technology from the Phobos-Grunt mission to Mars will be applied to the lunar mission, to the maximum extent possible, Zaitseva said.

There will be a second Lunar-Glob mission, Zaitseva said, which will deploy a lander and a rover, for a one-year mission. The landing site will be at the south pole of the Moon, with investigations to detect water ice, and to study surface magnetic anomalies. Russia will make use of its extensive lunar experience in the 1970s, in developing the lander and rover. International cooperation is also expected in this second Lunar-Glob mission.

The major, second phase of Russian lunar exploration, termed Lunar-Grunt, will begin with the delivery of a heavy long-range rover that will be equipped to collect soil samples, and do primary chemical processing. It will also include a robotic complex to transfer the samples to a future vehicle, and it will deploy a radio beacon to aid in precision landing of a second craft to follow. In the second phase of the Lunar Grunt series, samples that have been collected from the Moon will be transferred to an ascent vehicle, which will take off from the Moon's surface and deliver the samples to Earth. This two-mission Lunar-Grunt second phase is envisioned in the 2014-2015 time frame.

A fascinating proposal for a possible third phase was also described by Zaitseva of a lunar base, or "polygon," which would be delivered unmanned to the Moon. This automated technology complex would be used to support later manned missions, and could include transportation, communications, and power-producing functions, and perform "housekeeping" tasks to keep the base in working order until people arrive. It could also include scientific modules, with autonomous scientific stations, long-range rovers, and telescopes.

On to Mars!

Russia has suffered an overwhelming number of failures in its robotic Mars program, and nothing has been attempted since the mid-1990s. The Phobos-Grunt mission, slated for liftoff in October 2009, will be Russia's effort to regain momentum in planetary exploration.

It is an ambitious mission, to land on the tiny moon of Mars, collect samples of soil and rock, and return three to five ounces of the samples to Earth. Through the mission, Russian scientists expect to learn about the early period in the Solar System, when the asteroid belt between Mars and Jupiter was formed, and small bodies, such as the Martian moons Phobos and Deimos, were scattered about.

NASA

NASA Administrator Mike Griffin, who is passionate about the importance of the human exploration of space, explains that it is not simply a program, but helps define the greatness of nations, and requires a long-term vision, a multi-generational commitment. He is photographed here at the Kennedy Space Center in Florida.

China's diminutive Yinghou orbiter is hitching a ride to Mars aboard Russia's Phobos-Grunt spacecraft. It will be China's first deep space mission.

From the beginning of the planning for the Phobos-Grunt Mars mission, Russia invited international cooperation in the complex project. In 2006, Russia announced that China would participate, supplying a microsatellite to be carried on the Russian spacecraft. The Chinese Yinghuo-1 will be sent into orbit around Mars before Phobos-Grunt lands on Phobos, and will study the planet's atmosphere. In March 2007, cooperation was affirmed in a formal cooperative agreement, and joint groups were assigned by the two nations to carry out the project.

The French space agency CNES has supplied a gas-analysis instrument package for the mission, to study the molecular composition of Phobos's soil. The European Space Agency (ESA), has also lent a hand. In an effort to help the Phobos-Grunt mission succeed, Europe's Mars Express orbiter took close-up photographs of Phobos, in a series of five flybys this year, the final one skimming just 60 miles above the surface. The high-resolution photographs will be used to help find a suitable landing site for the Russian spacecraft.

Russia has extensive space cooperation with ESA, including the construction of a new launch facility at ESA's space center in Kourou, French Guiana. The new Soyuz lunch pad will provide Russia with a near-equatorial launch site, which increases the amount of payload a rocket can carry, using the same propulsive power. This will allow the launch of heavier geosynchronous satellites than can be lofted from Russia's Plesetsk and Kazakh Baikonur sites. The first two Soyuz-ST rockets are scheduled to be launched from Kourou in early 2009.

For decades, the Soviet Union used its manned access to space to invite foreign nations to fly to Earth orbit. More than 20 years ago, India's only astronaut flew to the Salyut space station. In March 2008, India and Russia announced that Russia has offered to fly one or two Indian astronauts on a Soyuz by 2011. India will need to create new infrastructure to be used in its future manned space program, and the training that the Indian astronauts will receive in Russia will help them in this effort.[2]

In April, the Indian Space Research Organization submitted its formal proposal

2. See "India Takes Its First Step to Put a Man Into Space," *EIR*, Feb. 23, 2007.

JAXA

Using the most sophisticated high-definition technology, Japan's Selene/Kaguya spacecraft took a series of photographs of the Earth rising above the lunar horizon. Click on the link to see the 59-second movie that JAXA created from these stunning images: http://space.jaxa.jp/movie/20080411_kaguya_movie01.e.html

to the government for a first manned mission in 2015, which is awaiting approval. ISRO chairman Madhaven Nair explained that it would use India's geosynchronous satellite launch vehicle to put a crew into low-Earth orbit.

The Challenge

And the United States? The only nation to have landed men on the Moon, robotically visited every planet in the Solar System, and peered into the universe with space telescopes, has been given a "vision," but inadequate resources to carry it out. Lack of support—both political and budgetary—from the Bush Administration has left NASA's Moon/Mars program punctuated with a question mark.

NASA Administrator Mike Griffin has explained to Congress and the Administration what the agency faces: deadlines will not be met in the Moon/Mars program; thousands of highly skilled jobs will be lost during the growing gap between the retirement of the Space Shuttle and the flight of the next vehicle, Orion; other critical infrastructure will be laid to waste; space science and planetary exploration missions will be scaled back, or even cancelled.

In a presentation in Washington on Sept. 24, to celebrate the 50th anniversary of NASA, Griffin remarked that if China successfully launched its Shenzhou VII spacecraft the next day, the number of Chinese people in space would "outnumber the number of Russians and Americans in space," referring to the joint Russian/American crew on the International Space Station. Griffin, who visited China's space facilities two years ago, believes that using the technology already under development, China could launch a manned mission to orbit the Moon, before the United States is ready to return, by 2020.

In an interview with the BBC during a trip to London in July, Griffin added that "it is possible that if China wants to put people on the Moon, and it if wishes to do so before the United States, it certainly can. As a matter of technical capability, it absolutely can."

Grasping at straws, in response to the seriousness of the situation, Congressional representatives and other supporters have tried to concoct a threatening "space race" between the U.S. and China, to try to motivate legislators to support NASA. That is not the reason to explore, as China, India, South Korea, and other nations recognize.

As Griffin has often stated, great nations lead great projects. The commitment that nations make to explore space is one measure of that greatness.

A Long-term Vision of Man in Space

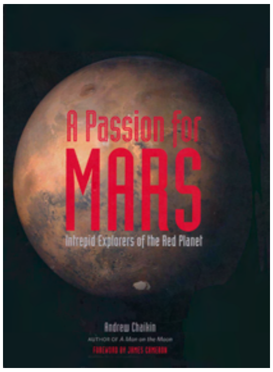
by Marsha Freeman

A Passion for Mars: Intrepid Explorers Of the Red Planet
by Andrew Chaikin
New York: Abrams, 2008
Hardcover, 272 pp., $35.00

Mars is a changing planet, and our understanding of Mars has also been changing, especially since the first spacecraft gave us out-of-this-world close-up views of the red planet, in the 1960s.

At present, there is a pair of expeditionary robots on the surface, working in tandem with a team of satellites in Mars orbit. As their data are relayed back to Earth, scientists have had to periodically "rewrite the book" on Mars, superseding existing theories. So, it is to be expected that there is a steady flow of new publications about Mars, just to keep up with the new developments.

But Andrew Chaikin's Mars book is unique. In addition to recapping the history of the twists and turns of our understanding of this dynamic world, and updating us on the new discoveries, through both words and spectacular photographs, he approaches the exploration of Mars as



seen through the personalities of the people who brought it about.

The book demonstrates that scientific discoveries, especially those which are, as he stated in an interview, "at the limit of what we know how to do," are not made "objectively." Fundamental advances in our knowledge are a function of the *passion* of the discoverer, most emphatically when it comes to exploring Mars.

Unlike research that can be carried out in the laboratory, according to the schedule of the scientist, sending spacecraft to Mars is a once-in-26-months opportunity. If a mission fails, it is two years, and at least hundreds of millions of dollars later, before another attempt can be made. Scientists who are determined to study Mars, Chaikin explains, must be able to dedicate literally decades of their lives and careers to the endeavor, live with disappointments, and never lose the drive to move forward.

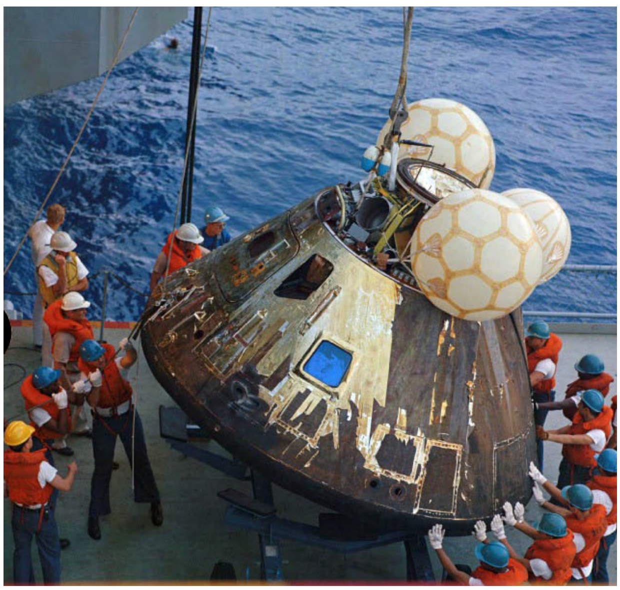
To do that, requires not only scientific interest and curiosity, but a *personality* that is anchored by dogged determination, and centers upon a commitment to a goal that is beyond the individual career, and often the individual lifetime, of the explorer.

Passion is a human quality, but the subjects of the subtitle of Chaikin's book, the "intrepid explorers," have, so far, only been robots. "I would make the case that the robots are extensions of the humans who built them," Chaikin says. Steve Squyres, the principal science investigator for the Spirit and Opportunity rovers that are still exploring Mars, told Chaikin that "passion is what got those rovers to the launch pad."

The Quest of Generations

One of the central figures in Chaikin's book, and in the quest for the exploration of Mars, is Tom Paine. He was the Admin-

NASA



NASA Administrator Thomas Paine (center) and other NASA officials applauding the successful splashdown of the Apollo 13 crewmen in 1970. At right: Crewmen aboard the U.S.S. Iwo Jima*, prime recovery ship for the Apollo 13 mission, hoist the Command Module aboard the recovery ship, April 17, 1970.*

istrator of NASA when we landed on the Moon. Following that success, he was called upon to formulate what the post-Apollo program for the United States should be in space exploration. The plan, with the input of Wernher von Braun, was to culminate in manned missions to Mars. But President Richard Nixon nixed that plan.

Nearly two decades later, after the first Space Shuttle flights, Paine directed another study on long-range goals for President Reagan, through the National Commission on Space. Again, the plan laid out a visionary Mars exploration program.

Unfortunately, the release of this report was overshadowed by the January 1986 Space Shuttle Challenger accident, and was never implemented.

Willing to work "outside the system," and undiscouraged, Tom Paine became an enthusiastic supporter and *eminence grise* for a group of "young turks" in graduate school, whom Chaikin describes as "almost renegade types." These young people organized the Case for Mars conferences in the 1980s. They were "very much outside the mainstream of the space community," Chaikin noted, and were "bucking the tide," as no one else was talking about missions to Mars.

It would be 20 more years, and long after Tom Paine were sadly gone, that the Vision for Space Exploration, announced by President Bush in 2004, would put manned missions to Mars on the agenda as a legitimate goal for space human exploration.

A Vision Sustained

After multiple "defeats," how did Tom Paine sustain a vision over decades, and never lose his optimistic view for the future? *Passion*.

Andrew Chaikin related to this writer that he had interviewed Tom Paine several times, the first, at the 1984 Case for Mars conference. It was clear, Chaikin observed, that Paine saw himself "passing the torch," in this "multi-generational quest" to explore Mars. What Tom Paine would not live to see in his lifetime, he was sure would be created by the next generation.

The passion of Tom Paine, and of NASA's Apollo-era Administrator, James Webb, emanated from the belief that the manned space program not only fulfilled a drive to explore, but the human and material resources that had to be mobilized for such "quests," would have a profound impact on the future of human civilization, as a whole.

In his 1984 Case for Mars conference presentation, Tom Paine outlined how, over the next 100 years, international cooperation in space exploration would not only extend the space frontier, but could help create "peace and prosperity," around the globe.

NASA

James E. Webb, NASA Administrator (center), talks to Harold Mullins, U.S. Army Corps of Engineers (left), and O.L."Dusty" Rhodes, NASA, in the early days of construction of the rocket test facility in Mississippi.

Promoting the General Welfare

Chaikin's approach in *A Passion for Mars* stands in stark contrast to what often passes for space history by people who are not "passionate" about space, but instead write "scholarly works" that substitute academic studies and footnotes for an understanding of the process of scientific inquiry and of achievements in space exploration.

One such example is a paper presented at a history session of the International Astronautical Congress in Glasgow, Scotland in the Fall of 2008. The paper by Roger Launius, a former NASA historian who is currently at the Smithsonian National Air and Space Museum in Washington, proposed to show that Apollo-era NASA Administrator James Webb had mistakenly believed that what had made the Moon landing program a success, could be transferred to help solve other problems in society. Launius labels the "expression of political power" in the "social activism" of people like Webb as a concept he calls the "positive liberal state." This, he derides, as a "crusade."

The truth is otherwise. Webb believed, as did Tom Paine, that the application of developments in science and technology, driven by the space program, could contribute to solving the societal problems of poverty, social inequity, and economic stagnation. Having come to Washington during President Franklin Roosevelt's New Deal, Webb understood that a Federally directed "Space Age America" could help strengthen the educational and economic potential of the nation.

During his presentation in Glasgow, Launius said that Webb, and others, believed (naively, in his view) that the government had a role to actively "promote the general welfare." Launius was reminded by this writer, that it was not Democrat "social reformer" James Webb who had created that concept of the role of government, but the founding fathers, in the Preamble to the Federal Constitution!

That the advances in science, technology, and management that NASA created did not solve the economic and social problems of 1960s America, had nothing to do with the space program. It was, in fact, a function of the lack of a passionate commitment to the promotion of the general welfare on the part of policymakers, which virtually stopped space exploration, after Apollo

Man on the Moon, and on Mars

In *A Passion for Mars,* Chaikin not only sheds light on the passion of the scientists, engineers, and managers who have created the Mars exploration programs, but weaves his own personal story throughout the book. From a childhood interest in, and fascination with Mars, he traces his academic study, his participation in Mars missions at the Jet Propulsion Laboratory, and his decision to write about this remarkable quest of exploration, rather than become a professional planetary geologist.

Chaikin's previous work, *A Man on the Moon,* which was made into an HBO series titled "From the Earth to the Moon," was based on interviews with the Apollo astronauts. Similarly, *A Passion for Mars* combines the facts of the history of Mars exploration, with the personal histories and personalities, of the central figures.

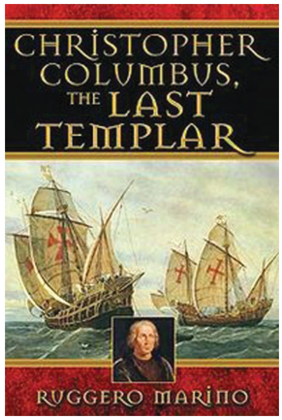
In explaining his approach to the writing of space history, Chaikin says: "I never pretended that I was impartial. I am not an objective academic. That's not my role. I've tried to delve into the history with a point of view." Like James Webb, Tom Paine, Wernher von Braun, and the other space scientists, engineers, and visionaries, Chaikin says, "One of the reasons that I find space exploration so compelling, is that you have to be focussed on the long term. You have to be thinking not only of the future of our current society, but the future of the human species."

This space exploration program, Chaikin says: "is going to continue long after you and I are gone, and will keep going as long as humans are capable of exploration. I feel that it is a real blessing to have in your life, an interest in something that is so profound and so far-reaching. The things that excited me when I was five years old are still exciting today, and they're just as compelling."

Christopher Columbus's Mission

by Charles Hughes

Christopher Columbus, the Last Templar
by Ruggero Marino
(Translated by Ariel Godwin)
Rochester, Vt.: Destiny Books, 2007
Paperback, 368 pp., $19.95



Ruggero Marino is a veteran journalist who has worked for the Italian newspaper *Il Tempo* in Rome since 1963. For many years he has also been a Columbus researcher, and he wrote a previous book on Columbus in 1992, *Cristoforo Colombo e Il Papa Tradito* (Christopher Columbus and the Betrayed Pope), available in Italian.

Marino, whose name ironically translates as "sailor," is a firm defender of the reputation of Columbus: "Centuries of injustice have reduced the man who enlarged the world, to someone ignorant who was limited to making it smaller. How has the belief persisted for five hundred years, that he thought he had arrived in China, when he knew he must seek a mythical land—especially considering the Indies referred to Eastern lands but not those that formed the Chinese Empire?" Marino asks.

Instead, Marino says, Columbus was part of a grand design to discover the New World! The Columbus expedition, he says, was a carefully planned project, led by Pope Innocent VIII, with Nicholas of Cusa, the polymath Paolo Toscanelli, and other Italian humanists.

Less successfully, Marino tries to show that Columbus was likely one of Pope Innocent VIII's 12 illegitimate children, known then as his nephews and nieces. This Pope, John Baptiste Cybo, was a patron of Italian Humanism, and was of Greek or Jewish and Muslim background. He was born on the Island of Chios, which in the 15th Century was under the rule of Genoa.

The grand plan was to discover and colonize lands in the western Atlantic, before the Turks thought of doing this. At the same time, Pope Innocent VIII was tireless in his efforts to make peace with the Turkish Sultan.

The Evidence

The book is dense with the historical connections of all those involved in this humanist project, which I won't attempt to fully summarize. The crucial points are these:

When Cusa died in Todi in 1464, there was a conference held at his death bed, attended by Toscanelli, the famous mapmaker Bussi, and Martinez, another mapmaker. Bussi was also a custodian of the Vatican Library. Columbus, who was then about 13 years old, was discussed.

In describing the deathbed meeting, Marino, among other things, quotes from a 1910 book published in Italian by Pirro Alvi, titled *Todi Citti Illustre dell Umbria* (Todi, Illustrious City of Umbria):

"And here we must speak of the famous Nicholas of Cusa, who died in our city. Acknowledged by many, he was the most well-read Cardinal that the sacred robe ever honored, the dearest friend of the great Pius II. At his deathbed were Toscanelli, Bussi, and Martinez witnesses to his testament. Columbus was discussed and the discovery of the New World."

This meeting was crucial for future exchanges of letters between Columbus and Toscanelli, as well as Columbus's marriage into the minor Portuguese royalty, to Donna Filippa.

As for the question of Columbus's maps: The Vatican at this time was the only institution in the world which could have had printed proof of Western Atlantic lands. For example, about the year 1100, the Church had sent a Bishop to collect tithes in Greenland and in the Norse colony of Vinland, which is now called Labrador. The Labrador cod fishing grounds were well known by 1300 to the fisherman of Bristol, England.[1]

A major mystery relating to the discovery of America, was, did Columbus have a map of the Americas? Marino thinks that he did, but offers little proof in his chapter titled "Three Map Monte."

Most accounts of the voyage of Columbus, including Marino's, tell you that Columbus attempted to get the Spanish King and Queen to support his expedition, without success, until early in 1492. At that point, ready to give up, Columbus visited the Rabida Monastery, and confided in Luis Sanangel, who collected money for the Church. Columbus then was allowed one more meeting with the royal couple, where he supposedly showed them either a book or a map, or a book containing a map, and was supported at once by the King and Queen.

A Map Showing America?

What did Columbus show them? Was it a map, or a book containing a map, which showed the American continents? Evidence that this is the case can be found in other sources such as Volume V in Washington Irving's Collected Works, *Columbus and His Companions* (New York: George P. Putnam, 1851). In the Appendix, Irving gives a detailed account of the testimony at a trial in 1515, where Arias Perez Pinzon, the son of Columbus's second-in-command, Martin Alonso Pinzon, was attempting to share in the wealth of the discovery by bringing suit against the heirs of Columbus, after his death in 1508.

Arias Perez Pinzon, Irving said, testified that on a visit with his father to the Papal Library, a "person learned in cosmography" had given them a document containing "a passage by an historian as old as the time of Solomon." The document said, "Navigate the Mediterranean Sea to the end of Spain and thence towards the setting sun, in a direction between north and south, until ninety-five degrees of longitude, and you will find the land of Cipango, fertile and abundant, and equal in greatness to Africa and Europe."

The son claimed that his father copied the document and intended to look for the new land, and that he had given Columbus a copy just before they set sail.

Irving states that although Arias Perez Pinzon had implied that this is what motivated Columbus's discovery, "Columbus had long before, however, had a knowledge of the work, if not by actual inspection, at least through his correspondence with Toscanelli in 1474, and had derived from it all the light it was capable of furnishing, before he ever came to Palos [from where he launched his journey].

"Columbus set sail on Aug. 3, 1492. The Pope, who had been in good health, died suddenly soon afterwards. In later times, both Innocent VIII and Columbus's discoveries and affiliation with the New World project, were ruthlessly covered up, and also slandered, by the Spanish oligarchy.

This book is worth reading for its great detail on the world of Columbus's time, and the connections among the people involved in the humanist plot to create America.

I am still puzzled, however, as to why Marino included in the title the phrase "The Last Templar," for he mentions almost nothing about the Templars, who had been outlawed in most countries, except England, Scotland, and Portugal. The only connection is that Columbus was a member of the Knights of Christ in Portugal, which was the successor to the Templar organization, and he used the Templar emblem on his sails. Also Columbus's second wife's father was an official in the Templars in Portugal.

Notes

1. For details, see Mark Kurlansky: *Cod: The Biography of the Fish That Changed the World*, (New York: Walker & Company, 1997).

Global Warming Update

Continued from page 11

emissions at the same time. Heads of government have other things on their minds."

And it isn't only Europe. On Nov. 28, Jim Prentice, the new Canadian Environmental Minister, said in his first speech after taking office: "We will not—and let me be clear on this—we will not aggravate an already weakening economy in the name of environmental progress."

Carbon Limits Kill, Says Indian Official

Capping his country's emissions would threaten the country's growth, and prevent it from alleviating the "energy poverty" which sees 500 million people live in darkness, India's top negotatior at the U.N. climate conference in Poland told the British daily *The Guardian,* Dec. 8.

"In India I need to give electricity for lightbulbs to half a billion. In the West you want to drive your Mercedes as fast as you want. We have 'survival' emissions, you have lifestyle emissions," Shyam said.

Carbon Caps Will Hurt Poor, Says London Think-Tank

"A cap on emissions of carbon would do little to protect humanity against the threat of climate change but would drastically increase the threat of global economic catastrophe," said a report issued by the International Policy Network in London on the opening day of the United Nations climate conference in Poznan, Poland.

The report, authored by Prof. Julian Morris of the University of Buckingham, said: "For Ministers in Poznan to agree to cap carbon emissions in the near term would be economic lunacy. It would divert resources into "low carbon" technologies and away from more productive uses—thereby harming the ability of the poor to address the real problems they face every day, such as diseases, water scarcity and inadequate nutrition."